Progress Report
Partnership in Health Project
July 2014–December 2014

Papua New Guinea Institute of Medical Research

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Authors

Dr. Bang Nguyen Pham	Scientific Coordinator	bang.pham@pngimr.org.pg
Seri Maraga	Scientific Officer	serimaraga@gmail.com
Jacob Kumai	Scientific Officer	jaolbosaj1@gmail.com
Rebecca Emori	Scientific Officer	rebecca.emori@pngimr.org.pg
Ronnie Boli	Scientific Officer	ronnie.boli@pngimr.org.pg
Tess Aga	Scientific Officer	tess.aga@pngimr.org.pg
Miriam Vano	Scientific Officer	miriam.vano@pngimr.org.pg
Regina Wangnapi	Scientific Officer	wangnapi.regina@yahoo.com
Prof. Peter Siba	PNG IMR Director	peter.siba@pngimr.org.pg

List of iHDSS team

	iHDSS site			
Team	Asaro/Goroka	Hiri/POM	Hides/Komo	Karkar/Madang
Data analysis	Ronnie Boli Miriam Vano Rebecca Emori	Seri Maraga		Dr. Regina Wangnapi
Data collection	Nanim Brown Jacob Joseph Alfred Alawaki	Lydia Kue Benjamin Fasi	Michael Kapu Billiam Degemba Vinson Silas Maryanne Hapolo	Jacob Kumai Campbell Asuak Noel Berry
Clinical and Laboratory	Helen Kave Albert Sie Jaukae Jaukae	Rosemary Simbil Beverlyn Warigi Theonilla Kware Vicky Gabee	Emmanuel Hapolo	Kaiok Mamore Ruth Larry
Data management	Tess Aga, Ronny Jorry Susan Bebes Collin Manase Joanne Tibu Morabi Joshua Dorothy Leo Freda Opgal			
Administrative and Financial	Maria Gipis Lynette Bureng Kim Papaso Lisa Kuvi Nancy Iva Roveleen Akunaii Masi Sima	Alexia Alois Felix Ame		Yalum Siba Babu Kudan

Note: This list as updated as of 31 December 2014

Technical Assistance of Independent Scientific Advisory Board (ISAB)

Maxine Whittaker, Professor of International and Tropical Health
Program Director AICEM and Co-Coordinator of APMEN Secretariat
School of Population Health, the University of Queensland

Marcel Tanner, Professor and Director
Swiss Tropical & Public Health Institute (Swiss TPH)
Chair of INDEPTH Board

Burt Singer, Professor (Adjunct)
Emerging Pathogens Institute
University of Florida

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Abbreviations

ACD	Active Case Detection
AIDS	Acquired Immune Deficiency Syndrome
ANC	Antenatal care
BCG	Bacillus Calmette-Guérin
BMI	Body Mass Index
CI	Confidence Interval
COPD	Chronic Obstructive Pulmonary Disease
CVD	Cardiovascular Disease
DENV	Dengue virus
DNA	Deoxyribonucleic acid
DOTS	Directly Observed Therapy - Short Course
DSS	Demographic Surveillance Survey
DST	Drug Sensitivity Test
DTP	Diphtheria, Tetanus and Pertussis
DWU	Divine World University
EHP	Eastern Highland Province
EMPNG	ExxonMobil PNG Ltd.
EPI	the Expanded Program on Immunization
EPTB	Extra Pulmonary Tuberculosis
GDP	Gross Domestic Product
GIS	Geographic Information System
GPS	Global Positioning System
HepB	Hepatitis B
Hib	Haemophilus influenza type B
HIV	Human Immunodeficiency Virus
HP	Hela Province

HPV	Human Papilloma Virus
HRV	Human rhinovirus
HSV-2	Herpes simplex type-2
IEC	Information, education and communication
iHDSS	Integrated Health and Demographic Surveillance System
IMR	Institute of Medical Research
IRB	PNG Institute of Medical Research Institutional Review Board
LAMP	Loop-mediated isothermal amplification
LBW	Low birth weight
LLG	Local Level Government
LNG	Liquefied Natural Gas
MCH	Maternal and Child Health
MDGs	Millennium Development Goals
MDR/TB	Multi-drug resistant tuberculosis
MMR	Maternal mortality rate
MRAC	The PNG Medical Research Advisory Committee
MTB	Mycobacterium Tuberculosis
N/A	Not applicable
NCD	Non-Communicable Diseases
NDoH	National Department of Health
NMR	Neonatal mortality rate
OPV	Oral Polio Vaccine
ORS	Oral rehydration salts
PCD	Passive Case Detection
PCR	Polymerase chain reaction
PICT	Provider-initiated HIV counseling and testing
PiHP	Partnership in Health Project

PNG	Papua New Guinea
PNG Med J	Papua New Guinea Medical Journal
PNG IMR	Papua New Guinea Institute of Medical Research
PNG LNG	Papua New Guinea Liquefied Natural Gas
POM	Port Moresby
PPAQ	Papua New Guinea Physical Activity Questionnaire
PSI	Population Services International
PTB	Pulmonary Tuberculosis
QMLR	Queensland Mycobacterial Reference Laboratory
SOP	Standard Operating Procedures
STI	Sexually Transmitted Infections
TB	Tuberculosis
TBA	Traditional Birth Attendant
UNs	United Nations
UNSW	The University of New South Wales
UPS	Urinary pregnancy test
UQ	The University of Queensland
VA	Verbal Autopsy
VCT	Voluntary counseling and testing
VDS	Vaginal discharge syndrome
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization

EXECUTIVE SUMMARY

As part of the Partnership in Health project (PiHP), the PNG Institute of Medical Research (PNGIMR) develops and submits semi-annual progress reports. This report covers and updates new data and finding since the last submission in September 2014. The work presented in this report includes (i) new data and results covering the six-month period fromJuly 2014 to December 2014 and (ii) whenever practical updated data available for the period January-March 2015 were also included in the report.

As an interim deliverable of the PiHP, the March 2015 Report assumes a basic understanding of the overall programme effort and does not reiterate well-known background information of either the PNG LNG Project or the PiHP. Whenever possible, the focus is on new results developed since the September 2014 Report. The PiHP is a longitudinal effort. Therefore, the presentation of certain types of time sequence information is critical.

Health, demographic indicators and socio-cultural determinants do not change rapidly. Rather, they evolve over a period of several years. The power of the integrated Health and Demographic Surveillance System (iHDSS) is its ability to reveal trends so that appropriate actions can be considered and taken by concerned stakeholders, authorities and individuals.

In the March 2015 Report, a new update of household data has been completed in the four surveillance sites, including GPS data of dwellings, population census data (including births, deaths, migration in and out of the surveillance sites), and morbidity and mortality data. This report presents major findings and observations of the iHDSSin interlinked chapters. Whenever possible, new findings and observations are emphasized in the specific iHDSS locations, i.e., Asaro, Hides, Hiri, andKarkar.

Five (5) topic/disease specific studies, which were also funded as part of the PiHP, have been completed as of December 31, 2014:

- Maternal and Infant Health (MIH);
- Sexually Transmitted Infections (STIs); also known as the “Healthy Pregnancy Study”
- Tuberculosis (TB);
- Sentinel Surveillance (SS) for Febrile and Diarrheal Diseases;
- Non-communicable Diseases (NCD’s).

Additional work is ongoing for the non-communicable diseases (NCD); however, updated chapters for all of these studies are included in the overall report. Because of the length and complexity of the demography and morbidity and mortality (M&M) chapters, the specialty study chapters are provided at the end of the overall report.

The following are highlights from the population demography studies to date:

POPULATION

- Over 54,000 individuals are under continuous demographic surveillance at four locations.
- Site locations include two PNG LNG impact sites, Hiri and Hides and two comparison locations Karkar Island and Asaro.

- Population growth appears to have stabilized at impact sites and a modest out migration was noted at all locations, impact and comparison.
- Hiri had the highest net population growth due to a combination of high crude birth rate and low crude death rate.
- Hides had the 2nd highest net population growth again related to differences in birth versus death rates.
- "Birth Boomlet" likely occurred in Hiri and Hides probably driven by rising incomes/improved employment.

Summary rate comparison is shown in the table shown below.

Growth Rates per 1000 Population

	Hiri	Karkar	Hides	Asaro	PNG
Birth Rate	20.3	8.2	17.7	11.5	30.2
Death rate	0.9	2.5	2.4	3.2	7.6
Pop growth Annual %	1.94%	0.57%	1.52%	0.82%	2.26%

- Key childhood mortality rates are now reported (shown in the table below).
- Project impact locations significantly outperform comparison locations. Hiri generally outperforms national reported rates

Childhood Mortality Rates

	Hiri	Asaro	Karkar	Hides	All sites	National (2012)
Children U5 mortality rate (per 1000 live births)	35.43	473.68	111.11	145.30	150.99	63
Infant mortality rate (per 1000 live births)	15.75	210.53	45.75	47.01	60.93	48
Neonatal mortality rate (per 1000 live births)	15.75	201.75	45.75	29.91	54.30	24

Education

As reported in September 2014 Scientific Progress report. No update for 2015 March report.

- Educational attainment is improving in PNG, particularly for the younger generation, ages 5-24.
- There are marked improvements in overall early educational attainment for all four iHDSS locations (Hides, Hiri, Asaro, Karkar) age 5-24 year cohort versus the >age 24 group. Females are significantly closing the previously documented "education attainment gap".
- Overall all sites, both sexes combined age 5-24 no school- 15%; age >24, 28%; some primary school- age 5-24 67%; age >24, 41%.
- Historically there has been an overall persistent male versus female attainment gap but has significantly improved in the 5-24 year old cohort across all sites.
- Hides female educational attainment improved, specifically, (i) "no education" improve, i.e., the number of females receiving "no education" declined from 71% in the >age 24 cohort to 53% in the age 5-24 cohort; and (ii) "some primary" improved (increased level of attainment/participation) with 20% female >age 24 to 41% female age 5-24.Educational attainment/improvement is shown by comparing the different cohorts of females ages 5-24 versus ages >24.
- Hiri "some primary" female age >24 28% to 60% age 5-24; the no education age >24 and age 5-24 are very similar.
- The comparison sites, Karkar and Asaro educational attainment data are under analysis.
- Improved employment and income could be potential explanatory variables but this requires further investigation.

Employment

- The PNG LNG project had a marked impact on the occupational structure of Hiri and Hides versus the comparison sites.
- Impact locations had large numbers of working age population who reported work associated with the PNG LNG Project.

In/Out Migration

- Project induced In/Out-migration did occur at Hiri and Hides but is not perceived to be a significant driver of population change at Hides or Hiri. The most common reason for both in and out migration recorded was "Marriage/family affairs", followed by security/conflict reasons (Hides) not project driven based on iHDSS household survey findings.
- Hides and Hiri populations have stabilized since PNG LNG project moved into operations although low out migration rates are still occurring. The destination(s) for out migrants is not known.
- Overall longitudinal Hiri and Hides in-migration appears to be consistent with expected trends, i.e., PNG LNG project induced in-migration and at levels anticipated and observed at other large development projects.
- The out migration rates were relatively higher than the in migration rates for all iHDSS sites during reporting period (July 2014 – December 2014).
- The top two (2) reasons for in migration movement for each site is detailed below:
    - Hiri: Marriage/family affairs and work/employment
    - Hides: Marriage/family affairs and security/conflict
    - Asaro: Marriage/family affairs and security/conflict
    - Karkar: Work/employment and Marriage/family affairs

- The top two (2) reasons for out-migration movement for each site is detailed below:
  - Hiri: Marriage/family affairs and work/employment
  - Hides: Return to original place and Marriage/family affairs
  - Asaro: Marriage/family affairs and return to original place
  - Karkar: Marriage/family affairs and Return to original place

Hiri experienced the largest gross migration trend during reporting period.

Summary data are shown in the table below.

Migration Rates by Site, iHDSS, 2015

		Asaro	Karkar	Hides	Hiri
	Population size	**9,953**	**18,623**	**13,253**	**12,404**
In-migration	Number of In-migrants	81	4	153	285
	Crude In Migration Rate (%)	0.81	0.02	1.15	2.76
Out-migration	Number of Out-migrants	151	136	159	453
	Crude Out Migration Rate (%)	1.52	0.73	1.2	4.39
Gross Migration	Total number of In and Out Migrants	232	140	312	738
(In-Migration + Out-Migration)	Crude Gross Migration Rate (%)	2.33	0.75	2.35	7.15
Net Migration	Net number of Migrants	-70	-132	-6	-168
(In-Migration – Out-Migration)	Crude Net Migration Rate (%)	-0.70	-0.71	-0.05	-1.62

SCIENTIFIC HEALTH STUDIES:

Tuberculosis

An extremely high prevalence of TB is documented in Kikori, Hiri and Karkar and when combined with the observed presence of drug resistant TB cases, it is clear that a significant emerging public health threat is present. The study findings conclude that:

- Prevalence and incidence rates reported at study sites are markedly different to rates reported by the PNG National Department of Health in 2013, and
- A silent TB epidemic is occurring at the study sites with serious public health implications and potential consequences if not addressed.

TB Study Incidence rates per 100,000 are listed below:

- Kikori IMR 1290/100,000; NDOH 815;
- Hiri IMR 458/100,000; NDoH 165
- Karkar IMR 630/100,000; NDoH 276
- Hides IMR 36/100,000; NDOH 84

Drug resistant TB is emerging as major concern with 10% at Kikori and 6% at Hiri.

Febrile, Diarrhoeal, Respiratory Disease (Sentinel) Surveillance

- This study focused on investigating causative pathogens for diarrheal and febrile diseases presenting to the clinics in the study sites.
- PNGIMR developed and activated over 60 real-time PCR assays for febrile, diarrheal and respiratory diseases. This is of enormous scientific and public health benefit to PNG.
- These assays allow for accurate and rapid determination of the potential causative agent(s) of symptomatic individuals who present to health centres.
- Total sample collection numbers are detailed below:

Location	Collection Period	Samples Collected		Total Samples
		Stool	Blood	
Asaro	May 2012 to Sep 2014	22	110	132
Hides	Aug-Nov 2013 and Aug 2014	33	32	65
Hiri	Aug 2013 to Oct 2014	53	105	158
Karkar Island	Nov 2013 to Nov 2014	10	146	156

Febrile Illness Study results:

Hiri (105 samples)

- One (1) Dengue
- One (1) Barmah Forest virus
- Nil Malaria

Hides (32 samples)

- One (1) Dengue
- Nil Malaria

Asaro (110 samples)

- 18 Chikungunya virus (During nationwide outbreak Nov 2012 – Aug 2013)
- One (1) Dengue
- Nil Malaria

Karkar (146 samples)

- One (1) Leptospirosis
- 47 Malaria

Based on the 393 samples collected from patients with a febrile illness, the observed resultsdo not reveal a dominant vector borne agent for the febrile illness. The results indicate that malaria is not a key febrile illness agent in Hiri, Hides and Asaro. This is consistent with current national prevalence surveys that show that laboratory confirmed malaria prevalence is <2%.Karkar prevalence is likely much higher indicating that the malaria is most likely more prevalent at specific geographical locations across PNG. Malaria can be introduced to non-endemic areas through human travel and movement. Dengue fever cases were small; however, both the vector and virus are present and a

sudden outbreak is always a realistic possibility. PNG has had outbreaks of various vector-bourne viral diseases, e.g., Chikungunya. Zika virus, a newly emerging viral disease, is spreading in the Pacific and PNG is clearly at risk.

Diarrheal Study Results:

Hiri (53 samples)

- Shigella and Campylobacter spp (during Oct 13- Apr 14 period)
- Rotavirus and Norovirus G2 (during mid 2014 period)
- Shigella, Campylobacter spp and Norovirus were dominant in most co-infections

Hides (33 samples)

- Campylobacter spp dominant 64%
- Shigella and Rotavirus prevalent

Asaro (22 samples)

- Shigella 41%
- Campylobacter spp 27%
- Rotavirus

Karkar (10 samples)

- Rotavirus and Adenovirus

Rotavirus is present across all sites suggesting poor personal hygiene practices and campylobacter spp is dominant at Hides suggesting poor food hygiene practices and/or poor personal hygiene practices associated with close contact with animals including poultry or pigs.

Maternal and Newborn Health

Key findings of Maternal and Newborn Health Study indicate significant number of women deliver babies without attendance of health professional with an extremely high maternal mortality rate (likely between 500-750/100,000. Vaccination coverage rates across study sites are very poor and consistent with the observed pattern of dramatic communicable disease outbreaks) e.g., measles) across PNG. This study illustrates that a severe ongoing problem in maternal care delivery is present.

Key findings are listed below:

- Hides vaccination rates are 2-3 times below international norms and 50% below international standards in Asaro.
    - Access to functioning clinics, however vaccination rates below international standards but better than other iHDSS sites. *(Hiri is closer to Port Moresby, more urbanized and has a significantly higher female educational attainment level than the other sites).*
- Measles vaccination coverage very poor at all study locations at 15-17%.Compared to WHO standard of 90% coverage (global).

- iHDSS site vaccination rates are well below international norms. The PiHP studies confirm the ongoing vaccination coverage issues and the need for aggressive public education and emphasis on service delivery and support.
- Almost 500 women were surveyed regarding their most recent pregnancy at Hiri, Karkar and Asaro.
- Hiri significantly outperforms other study sites with women have:
    - Better knowledge of danger signs in neonates;
    - Significant differences in educational attainment;
- Pregnancy (antenatal) care does not meet minimum standards as outlined by the National Department of Health.
- Numerous opportunities to monitor for risk factors in pregnancy were missed at all sites.
- Danger signs of pregnancy occurred in one third of all pregnancies.
- Almost 50% of the women experienced a problem during pregnancy or childbirth.

Sexually Transmitted Infections (Healthy Pregnancy Study)

A landmark scientific study regarding STIs in pregnant women in PNG was performed. This studyalso included a large cross-sectional bio-behavioural survey. There were 765 women participants in antenatal clinics with Hiri-255, Hides-252 and Asaro-258. Karkar was not studied. The study included research into the prevalence of common STI infections including Chlamydia, Gonorrhoea, Trichomonas, Herpes 2, HIV, Syphilis and Human Papilloma Virus (HPV).

Key findings include:

- PNG STI prevalence rates among highest in the Asia-Pacific region.
- 44% of women in Hiri, Hides & Asaro had one or more infections of chlamydia, gonorrhoea or trichomonas with 80% infections asymptomatic.
- HIV rates consistent with PNG rates:
    - Hides 0.5%,
    - Hiri 1.6%,
    - Asaro 1.5%
    - PNG national rate 1% with higher levels in urban settings
- Herpes Simplex Virus (HSV) rates are 28%.
- Human Papilloma Virus (HPV) rates are 43%. HPV is a significant cause of cervical cancer and is the most common cancer among women in PNG and a leading cause of death for PNG woman. The findings conclude that the available and highly effective HPV vaccine has the potential to significantly reduce the burden of HPV-related cervical cancer in PNG.

Non-Communicable Diseases (NCD's)

The study is establishing baseline prevalence for selected NCDs, associated lifestyle risk factors, dietary habits and food security at three iHDSS locations, Hiri, Karkar, and Asaro with a total of 774 participants. Hides was not included in the study during this period.

Key results include:

- There is a marked difference in body mass index (BMI) observed across the different survey locations:
    - Hiri- Underweight (7%); Normal (46%); Overweight (24%); Obese (22%);
    - Karkar- Underweight (12%); Normal (81%); Overweight (5%); Obese (1%);
    - Asaro- Underweight (4%); Normal (66%); Overweight 23%); Obese (6%).

- Significant levels of hypertension, elevated cholesterol/triglycerides and glucose are documented.
- Hypertension- Hiri (22%); Karkar (5%); Asaro (21%);
- Anemia- Hiri (34%); Karkar (72%); Asaro 24%);
- Abnormal lipids (elevated cholesterol % + elevated triglycerides %) – Hiri(68%); Karkar (29%) Asaro (51%);
- Elevated glucose—(pre-diabetes + diabetes) - Hiri (34%); Karkar (8%); Asaro (12%).
- Significant levels of NCD markers are observed particularly in the more urbanized and affluent Hiri area.
- There are significant public health implications for the study findings.

The reported findings indicate a substantial existing NCD burden in the general adult population of Hiri or, in the very least, a population at serious risk of developing a high NCD burden in the future.

Mortality

A longitudinal mortality study using verbal autopsies (VA) is ongoing across all four iHDSS locations.

- 1,487 VA have been completed over six years and a cause of death recorded and reviewed by the PiHP physician for 1,437.
- Evolving mortality patterns are observed at all four iHDSS locations. These include:
    - Rise in NCDs in Hiri, Karkar and Asaro;
    - Cervical cancer is a major issue and consistent with the high rates of HPV documented in the PiHP "Healthy Pregnancy/STI Study".
    - Hides mortality is dominated by a pattern of infectious respiratory diseases, particularly pneumonia; however, accidents and violence are important mortality drivers; Hides VA report indicate HIV/AIDS to be an important cause of death however VA data numbers in Hides are small and HIV/AIDS numbers should be cautiously interpreted. Hides HIV prevalence rate is 0.5% and stable based on data collected by the 'Healthy Pregnancy Study and contemporary reporting from other Hides area health centers. The VA study does not include HIV contact tracing therefore the place of acquiring infection is unknown.
    - Hiri is dominated by TB, followed by (All Cancers), diabetes and malaria. Malaria mortality data should be cautiously interpreted as over reporting is likely particularly on cases before the aggressive introduction of confirmatory laboratory testing.
    - Hiri is the most developed population in terms of urbanization and exhibits very high rates of TB and NCD's. This data supports the recommendation for intervention programs to be a high priority for the provincial and national government.

Top 3 causes of Adult death per site are:

Hides:

1. HIV (sample group very small)
2. Homicide
3. Pneumonia

Hiri:

1. All Tuberculosis
2. All Cancers
3. Diabetes / Malaria

Asaro:

1. COPD (Chronic Obstructive Pulmonary Disease)
2. All cancers (HPV & Liver)
3. TB

Karkar:

1. COPD *(Chronic Obstructive Pulmonary Disease)*
2. All cancers (liver & Mouth)
3. Cardiovascular / TB (tied)

Morbidity

Clinical data indicate that high levels of respiratory cases are presenting at local clinics with skin diseases and diarrhea also contributing heavily to clinical caseloads at most sites.

Top 3 causes of illness (Adults & Children) are:

Hides:

1. Diarrheal Diseases
2. Respiratory disease
3. Skin infections

Hiri:

1. Diarrhea
2. Skin infections
3. Respiratory Diseases

Asaro*:*

1. Respiratory disease
2. Skin infections
3. Diarrhea

Karkar:

1. Respiratory disease
2. Skin infections
3. Malaria

Overall, there continues to be significant scientific progress across all iHDSS locations. Population demography data collection has been enhanced and childhood mortality outcomes are reported for the first time. In and out migration is carefully tracked across all sites and populations are generally stable. Project induced in-migration occurred at levels equal to (Hides) or less than predicted (Hiri) by the baseline social impact assessment. Major scientific studies have been completed and results are reported. Important discoveries regarding NCDs, sexually transmitted infections (particularly HPV infection), TB and changes in mortality and morbidity patterns are being made as a result of the PiHP. There are significant public health policy implications of these PiHP studies. The Government of PNG and international donors, including NGOs, can build upon the PiHP study results in order to better direct and focus aid and intervention programmes.

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1.0 BACKGROUND AND INTRODUCTION

Papua New Guinea Institute of Medical Research (PNG IMR) has established and operated an ***integrated Health and Demographic Surveillance System*** (iHDSS) under the Partnership in Health Programme (PiHP) since 2011. The programme was financially supported by ExxonMobil PNG Ltd., with technical assistance from the University of Queensland, Australia. The iHDSS database is updated twice a year with new information on socio-economic, demographic and population changes in life-cycle events such as birth, education, employment, marriage, migration, and death. The iHDSS acts as a core framework so that other specialty studies can be performed, e.g., maternal and child health, sexually transmitted infections, tuberculosis, febrile surveillance, vaccination monitoring, etc.

1.1 THE iHDSS SITES

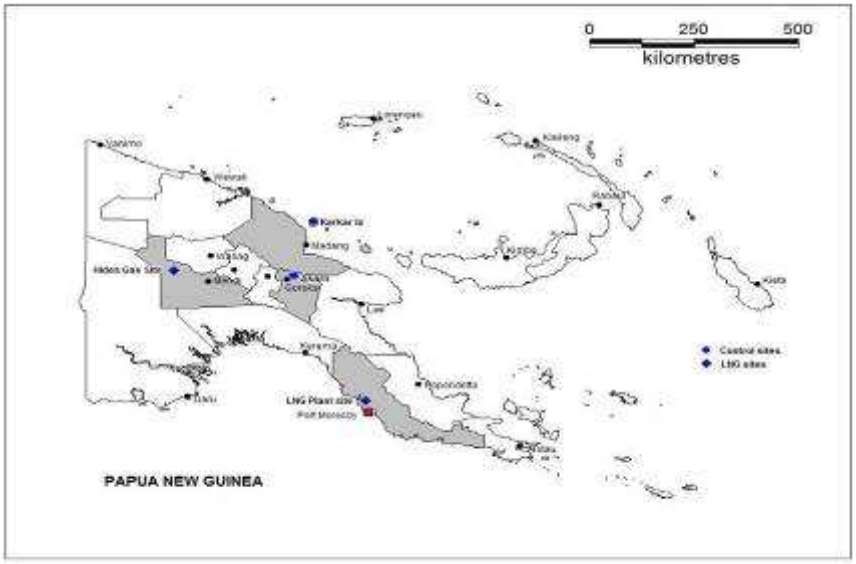

Figure 1-1. iHDSS sites: Asaro vs. Hides and Karkar vs. Hiri sites, PNG IMR iHDSS, 2015

Figure 1-1 shows the four iHDSS sites, including Asaro, Hiri, Hides and Karkar. The two PNG LNG sites are Hiri and Hides and are compared with Karkar and Asaro, respectively. The four sites include coastal (Hiri and Karkar) and mountainous areas (Hides and Asaro), and peri-urban (Hiri) and rural locations (Hides and Asaro). The iHDSS covers a total population of approximately 55,000 across the four study sites.

1.2 ASARO

With a total population approximately 10,000Asaro has its main industry in farming and agricultural production. Coffee is the main crop. The major languages spoken by people living in Asaro are *tokples,* Gahuku, Siane and Dano/Tokano and *pidgin.* There are four health facilities: *Goroka Provincial Hospital*, *Asaro Health Clinic, Urioka Health Clinic and Tafeto Health Clinic,* where local people can accessbasic health services. Asaro has more than 10 public and private schools where local children attend at the primary and secondary educational levels.

Figure 1-2. Map of Asaro iHDSS site and villages covered by the iHDSS, 2015

Figure 1-2 shows the villages of Asaro covered by the iHDSS. In the past, PNGIMR had an established demographic surveillance site in Asaro; however, due to lack of funding, the site was not fully operational. The Asaro iHDSS was re-established by the PiHP in 2011. Key villages are located approximately 40-45km northeast of Goroka town. The site is designed as a comparison site to Hides. There are 26 field reporters currently working in Asaro site.

1.3 HIDES

Hides iHDSS is considered to be a PNG LNG impact location as major construction occurred in Hides. In addition, there are long-term critical operations at the Hides Gas Conditioning Plant (HGCP). Hides iHDSS is located in the Hela Province. The initial Hides iHDSS included three divisions covering a population of approximately 15,400. Geographically, Hides iHDSS populations are scattered, and difficult to access. Ensuring adequate security for survey teams is a significant concern. Tribal cultural norms and practices are an integral part of the local people's lives, formulating close structure of the society. People live in small settlements composed of clans and sub-clans, and maintain a traditional tribal lifestyle. Most of the houses are traditionally built with very few permanent or semi-permanent buildings. The main *tokples* language spoken is Huli, which is also the common name given to people from this region. Other languages include *pidgin* and a small number of English speakers. Hides iHDSS site included the Komo Airfield, which was a major location during construction but has now been transferred to the PNG Government. The two main health facilities are Mananda Health Centre and Para Clinic, which are run by the Evangelical Church of PNG (ECPNG). There are elementary and primary schools, but no evidence of a functioning high school.

iHDSS has separated the area in to three divisions for reporting purposes: *Haliago* (Division 1), *Hibiria* (Division 2)and *Gigiria* (Division 3) (**Figure 1-3**). Due to a variety of logistical, security and financial considerations, the Hides iHDSS has now been focused on Division 3 the "home" of the HGCP. For2015 reporting, only Division 3 data are presented.

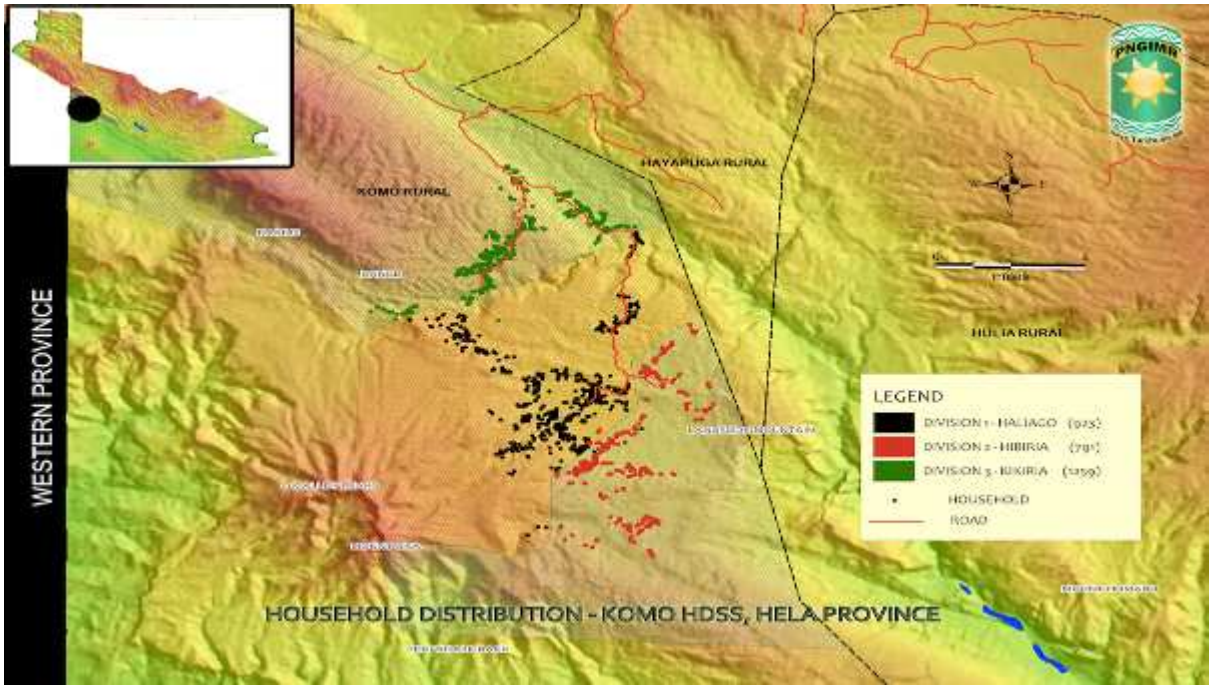

Figure 1-3. Map of Hides and division covered by Hides iHDSS, 2015

1.4 HIRI

The Hiri iHDSS is located west of Port Moresby, the National Capital of PNG. The iHDSS covers four coastal villages, including *Porebada, Boera, Papa* and *Lealea* (see

Figure 1-4) with the total population between 12,000 and 13,000. Most inhabitants are either *Motu* or *Koitabu* speakers. Hiri iHDSS can be reached by road in less than one hour from Port Moresby. The Hiri villages have become a peri-urban area due to proximity to Port Moresby and marked improvements in surface transportation connections between the villages and the national capital.

1.5 KARKAR

Karkar district is a volcanic island located 30km off of the PNG coast in the Bismarck Sea and is part of Madang Province. The iHDSS covers a population of approximately 18,500 (the total population of Karkar Island is about 60,000). Agriculture is extremely important and the island has large plantations that produce cocoa and coconut and provide significant local employment opportunities. Inhabitants of the island come from one of two language groups: *Waskia* in the North half of the island and *Taskia* in the South. Most inhabitants are either Lutheran or Catholic (see

Figure 1-5).

One main road runs around the coast of the island and provides access to the three available health facilities. Gaubin Hospital is the largest of the facilities and is a Lutheran run institution. Karkar has been unaffected by the extensive and intensive mining activity that has occurred in Madang; hence, Karkar is considered as an appropriate non-impact location for comparison with the coastal villages in Hiri.

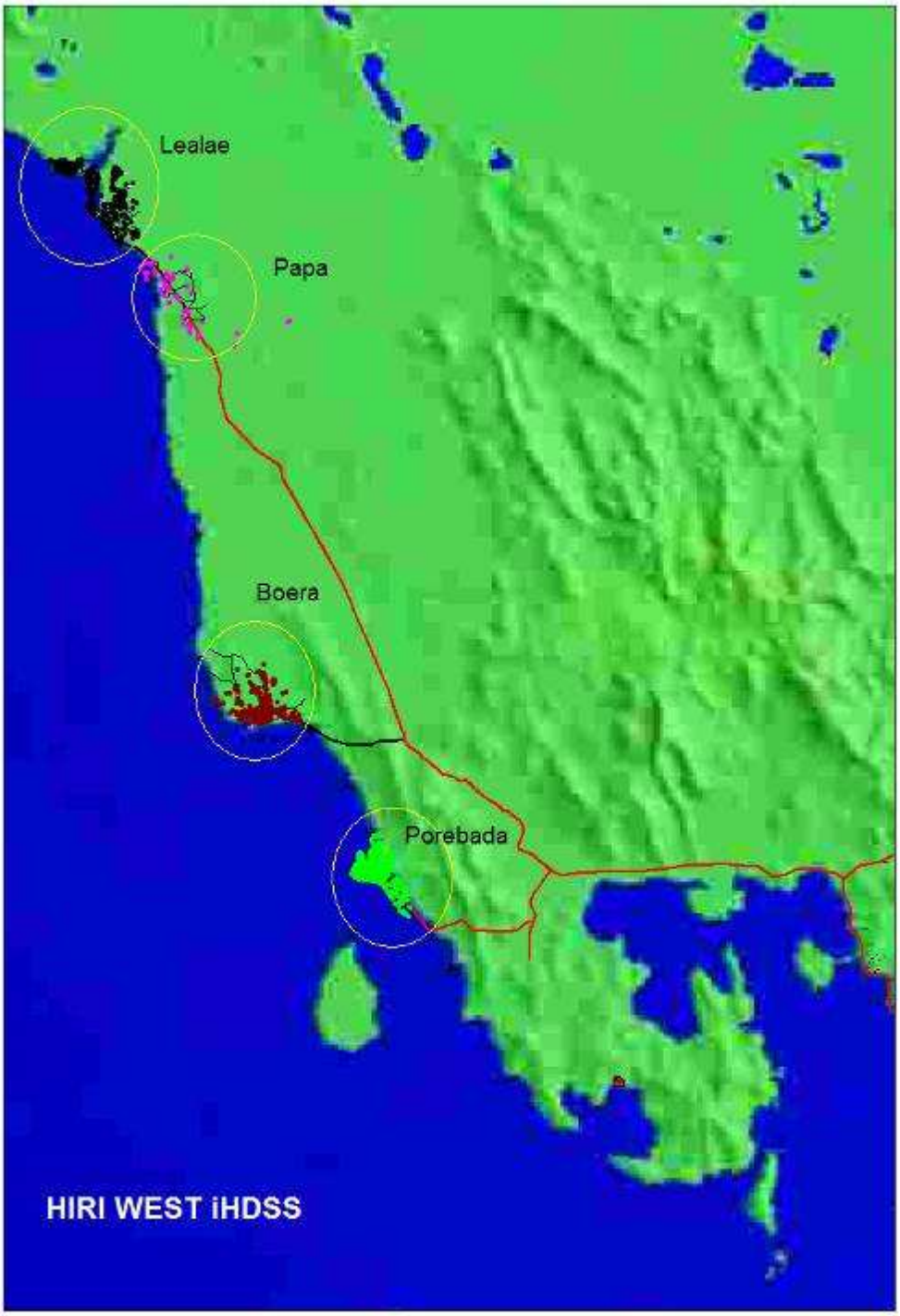

Figure 1-4. Map of Hiri and villages covered by iHDSS, 2014

Figure 1-5. Map of Karkar, iHDSS, 2015

2.0 METHODS AND MATERIALS

This Chapter provides details of the data collection tools, data collection method, data entry and management processes as well as quality assurance/quality check (QA/QC) procedures, currently applied to the data collection, data processing and data analysis for all iHDSS sites.

2.1 DATA COLLECTION TOOLS

2.1.1 Household Update Book

A new Household Update Book (UB) was developed, based on the last review of the data collection tools. This new HH UB was redesigned, based on the previous HH update book and integrated with other data collection tools such as Change Status Form, Household registration form, Birth registration form, and Death registration form. The updated materials are in-line with requirements of the INDEPTH network for recording and reporting population data. The new HH UB was used for collecting updated population data over the reporting period July-December 2014 and document major population changes at the household and individual levels in iHDSS sites (see Annex 1 for more details). The new Household UB consists of 7 data components, including:

(A) Household identification information[1];
(B) Individual identification information of household member[2];
(C) Births since the last update;
(D) Death occurred since the last update;
(E) In-migration[3] since the last update;
(F) Out-migration[4] since the last update;
(G) GPS data was also collected as part of the fieldwork; and
(H) Date of Update.

2.1.2 Morbidity data collection form

To collect morbidity data from iHDSS sites for this report, a collection form was used to collect tally numbers of case load recorded in health facilities within the iHDSS site over the reporting period.

2.1.3 Verbal Autopsy Questionnaire (VA)

Two VA data modules for adult and adolescents (Annex 2) were used in this reporting period to collect information on causes of death.

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[1] A new Household ID code system has been recently developed based on the HH and individual identification information. This coding system is in line with the national coding system issued by the PNG National Statistics Office and international convention. It will be applied for the first time in the data collection in Quarter 4-2014. That will help to link different components of the iHDSS database, between HH and Individual information and with other data sources available in PNG and the INDEPTH network.

[2] A HH member is defined as an individual who resides in the HH for 3 months or more in the last six months of the reporting period i.e. from 1 July to 31 December, 2014, including newborn babies less than 3 months old, and are currently living or not living in the household at the time of update. This is definition is adopted from the INDEPTH network.

[3] In-migrant is defined as an individual, who moves in the iHDSS site from outside and currently living in the iHDSS site at the time of survey or update. This definition is adopted from the INDEPTH network.

[4] Out-migrant is defined as individual, who used to live in the iHDSS site, recorded in the iHDSS database, but have already moved out of the iHDSS site prior to the update time. This definition is adopted from the INDEPTH network.

2.2 TRAINING

A training of trainers(TOT) training was conducted by the Scientific Coordinator for core staff of PiHP including site managers, fieldwork coordinators, and scientific officers from all four iHDSS sitesin late Oct 2014. The training focused on the new design of the iHDSS, including the new data collection tools such as the HH UB, HH Questionnaires, the Morbidity Questionnaire and Mortality Questionnaire (M&M).

This TOT training was then followed up by refresh trainings in each of the iHDSS sites. The refresh training was conducted by Site Managers in collaboration with Fieldwork Coordinators in November and December 2014 with focus on data collection tools and data collection processes which were applied in this reporting period.

2.3 DATA COLLECTION AND FIELD MONITORING

There has been no change in the data collection framework of the iHDSS over the last four years. Data collection forms and the HH UB have remained the same until the reporting period of Jan-June 2014. The newly designed HH UB, HH Questionnaire, and Morbidity Questionnaire were used for the first time to collect data for the reporting period, July-Dec 2014.

The Mortality Questionnaire was developed by the Population Health Metrics Research Consortium in 2007 and is currently being used by the PiHP. There is a minor change in the coding structure of the Mortality Questionnaire, from 4 digits to 19 digits to be consistent with the iHDSS coding system and facilitate data link with other data components of the iHDSS database.

Data collection process was closely monitored by Field-work Coordinators. Data collection forms, including the Household Update Book and Morbidity tally forms were checked by the assigned Data Editors in the field and verified upon arrival in the office by the Site Manager. Identified mistakes were highlighted and cross-checked with the Field-work Coordinators for clarifications and corrections.

The Morbidity and Mortality data for Hides were collected by a clinical team from Asaro. The Asaro clinical staff also provided similar technical assistance for the Karkar site.

2.4 DATA ENTRY AND MANAGEMENT

According to the new QA/QC procedures, data entry work was shifted from the Data Manager, who is based in iHDSS sites, to the data management team, based in PNG IMR main office in Goroka. This change has been made as part of QA/QC procedures to standardize data entry processes and unify data entry template, improve the quality of iHDSS data and build the iHDSS database.

The information was then entered into the PiHP central database by data entry clerks, who are based in PNG IMR offices in Goroka. The data management team has four data entry clerks. Each acts as a focal point for entering data of one site. HH UBs are entered into the iHDSS database, using the same data entry template, developed on the Process Maker programme. Data entry clerks are requested to check systematically every 10 individual entries.

One data quality controller supervises and monitors the data entry progress and provides technical support to data entry clerks when required.

Once all the information has been transferred from the HH UB into the iHDSS database, the data manager will review the database, edit the data if needed and extracts raw dataset as required. About ten percent of the responses were randomly cross-checked by the data managers in the second round of quality control during the data entry process.

2.5 DATASET GENERATION AND CLEANING

A "raw dataset" is the initial output of the data generation process. The HH UB dataset was extracted from the iHDSS database, using 'date of interview' conducted during the reporting period, between 1 July 2014 and 31 December 2014 from iHDSS sites. For M&M data, the analysis includes data collected in Quarter 1-2015.

Data sets were extracted from the iHDSS database in the form of a Microsoft Excel spreadsheet and checked by the Scientific Coordinator for the final round of quality assurance before they were released to the study design team for data analysis and report writing.

2.6 DATA ANALYSIS AND REPORT WRITING

A two-day training workshop on basic data analysis and report writing skills was held by the Scientific Coordinator for a core group of eight national Scientific Officers. With these newly acquired skills, the national scientific officers have been able (for the first time) to take part in the development of the PiHP progress report.

The newly "cleaned dataset" were then converted into SPSS (Statistical Package for Social Study) for the analysis of population data, producing tables and graphs.

MapInfo Package was used to develop maps of population and household distribution, using the GPS data.

Assessment of the quality of iHDSS data for the March 2015 report

Figure 2-1 describes the QA/QC procedures currently applied to the data collection, recording and processing for the iHDSS. This QA/QC procedure is divided into three stages covering three respective steps of data processing:

(i) Data collection;
(ii) Data entry and management;
(iii) Data generation.

2.6.1 Data collection

Data collectors conduct HH visits and individual interviews, using the HH UB. Every ten data collectors have one team leader who monitors, supervises, and certifies the completeness of data collection forms i.e. the HH UB. Each iHDSS site has one or two Fieldwork data editors, who are responsible for review of the collected information, make correction if needed and verifies the collected data. Fieldwork coordinator oversees the fieldwork activities in an iHDSS site to ensure

activities are planned and implemented in a coordination manner to meet the deadline. The fieldwork coordinator records and sends all the completed data collection forms to Goroka once he/she has completely checked and certified the collected data and information.

2.6.2 Data Entry and Management

Data entry clerks are assigned as a critical focal point for each iHDSS site. He/she is responsible for entering the information of his/ her iHDSS site into the database. Data entry clerks have systematically checked every batch of 10 entries. If all the ten entries are correct, then she/he will move forward. If any mistake is identified, then she/he will re-enter the whole batch. Data entry and management team has a QA/QC officer, who supervises, monitors the data entry processes and provide technical assistance to the data entry clerks. The data manager is responsible for the development of data entry templates, using MySQL/ process maker. The main task of the data manager is to maintain the iHDSS database to make sure all the data components are linked and generate the dataset for data analysis purpose by extracting raw data from the database on demand, using inclusion and exclusion criteria. He/she can edit the database if any error is detected. The raw dataset is then passed to the study design team for data analysis purpose.

2.6.3 Data cleaning

The Scientific Coordinator ran standard statistical tests and checked multiple entries of the generated dataset. Missing values were calculated, recorded and corrected if needed. The internal consistency within the dataset was also cross-checked and corrected. Outlier values were recorded for further examination to identify their potential contribution to the change in the data analysis results. The final dataset was then released for data analysis and report writing.

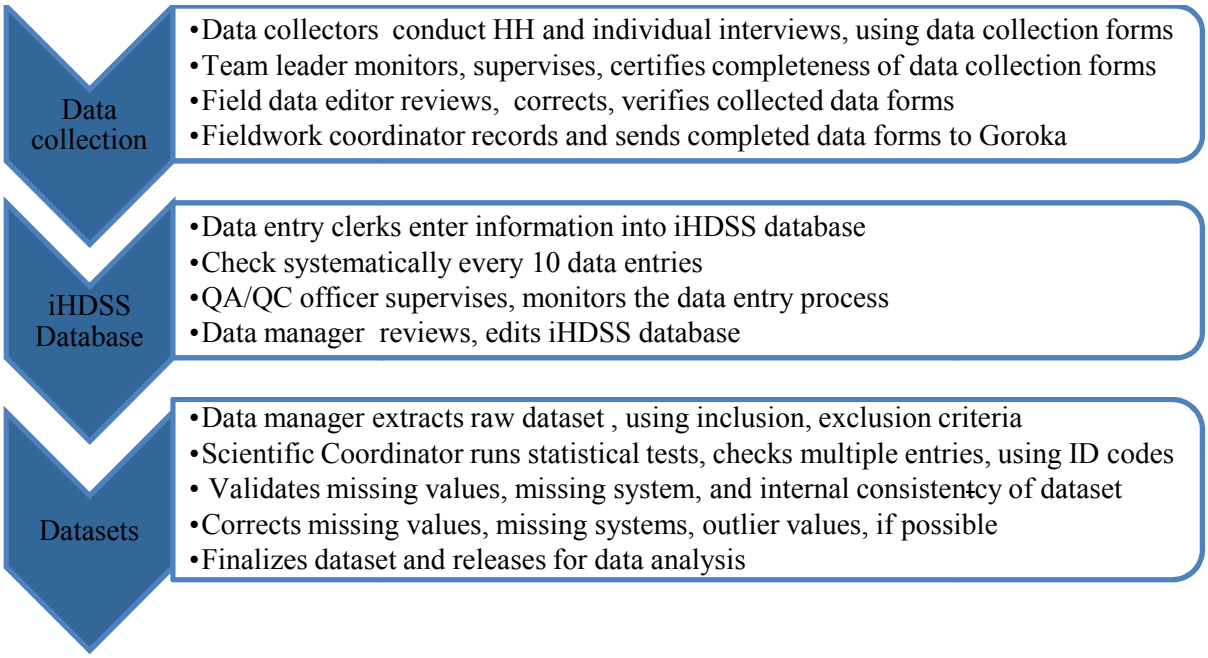


Figure 2-1. QA/QC measures of the PNG IMR iHDSS, 2015

Table 2-1shows the quality of population data, recorded in the iHDSS for the reporting period July-2014 December 2014. Four key variables are illustrated: Relationship to the HH head, Sex, Year of Birth, and Province of Birth for the four iHDSS sites: Hiri, Asaro, Karkar, and Hides.

Table 2-1 Quality of population data by iHDSS site, 2015

Variables	Data Values	Hiri		Asaro		Karkar		Hides		Total	
		N	%	N	%	N	%	N	%	N	%
Relationship to HH head	Valid values	10569	84.5	9802	98.5	18279	98.2	12977	97.9	51627	95.0
	DK values	15	0.1	2	0.0	4	0.0	9	0.1	30	0.1
	Missing values	1926	15.4	149	1.5	340	1.8	267	2.0	2682	4.9
	Total values	12510	100.0	9953	100.0	18623	100.0	13253	100.0	54339	100.0
Sex	Valid values	12393	99.1	9932	99.8	18595	99.8	13152	99.2	54072	99.5
	DK values	24	0.2	13	0.1	9	0.0	12	0.1	58	0.1
	Missing values	93	0.7	8	0.1	19	0.1	89	0.7	209	0.4
	Total values	12510	100.0	9953	100.0	18623	100.0	13253	100.0	54339	100.0
Year of Birth	Valid values	12186	97.4	9484	95.3	18465	99.2	11804	89.1	51939	95.6
	DK values	297	2.4	459	4.6	138	0.7	1319	10.0	2213	4.1
	Missing values	27	0.2	10	0.1	20	0.1	130	1.0	187	0.3
	Total values	12510	100.0	9953	100.0	18623	100.0	13253	100.0	54339	100.0
Province of birth	Valid values	12079	97.47	9473	95.38	18443	99.18	11758	89.40	51753	95.71
	DK values	287	2.32	449	4.52	133	0.72	1312	9.98	2181	4.03
	Missing values	27	0.22	10	0.10	19	0.10	82	0.62	138	0.26
	Total values	12393	100.0	9932	100.00	18595	100.0	13152	100.0	54072	100.0

The iHDSS has captured 54,339 population records[5] in four sites, including 9953 records (18.3%) in Asaro, 13,253 (24.4%) in Hides, 12,510 records in Hiri (23%), and 18,623 records in Karkar (34.3%). The above analysis indicates that the completeness of the data is very high, above 95% across all four selected variables with 99.5% for the data on 'Sex'. The 'Missing values' were less than 5% across variables, but was relatively high, 15.4%, for the variable on 'Relationship to HH head' at the Hiri site. Overall, the quality checks suggest that the iHDSS data for the reporting period July 2014 - December 2014 are reliable and suitable for further data analysis.

[5] Population records include: (i) Residents in iHDSS sites at the update times; (ii) Births bornin iHDSS sites since the last update; (iii) Deaths occurred in iHDSS sites since the last update; (iv) Migrants out of the iHDSS sites since the last update; and (v) Migrants into the iHDSS sites since the last update.

3.0 POPULATION SIZE, AGE AND SEX POPULATION STRUCTURE

3.1 ABSTRACT

This Chapter reports key findings and observations on socio-demographic characteristics of the study population in four iHDSS sites, namely Asaro, Hiri, Hides and Karkar. A total of 54,339 population records were extracted from the iHDSS Database by the end of March 2015, providing an updated data on dynamics and health status of the population over the reporting period July-December 2014. The data analysis focuses on key demographic indicators such as population size and population distribution. Individual iHDSS location data are also presented.

Table 3-1 shows the overall population records captured in the iHDSS sites, including Hiri, Asaro, Karkar and Hides as of March 2015. A total of 11,251 dwellings were included in the GPS database, with the population coverage of 54,339 individuals at the four sites. A total of 755 live births were captured in 2014 and were recorded in the system. 151 deaths were reported at the study sites. There were 278 persons who in-migrated into the study sites and 469 out migrations at the study site.

Table 3-1 Population Data Update by iHDSS site, 2015

Census Update	Hiri	Asaro	Karkar	Hides	Total
Number of dwelling	1,691[6]	2,872[7]	3,980[8]	2,708[9]	11,251
Population records	12510	9953	18623	13253	54339
Birth records	254	114	153	234	755
Death records	12	35	58	46	151
In-migration records	40	81	4	153	278
Out-migration records	23	151	136	159	469
Net migration	17	(70)	(132)	(6)	(191)

[6] Including 319 in Boera, 468 in Lealea, 228 in Papa, and 676 in Porebada

[7] Including 1224 in Asaro and 1648 in Goroka

[8] Including 1456 in Takia and 2524 in Waskia

[9] Including 1182 in Division 3 and 1526 in Division 1 and 2

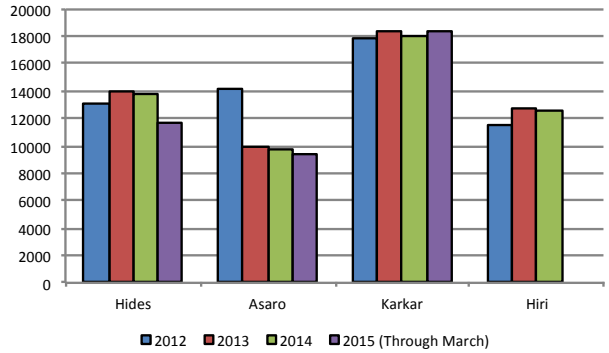
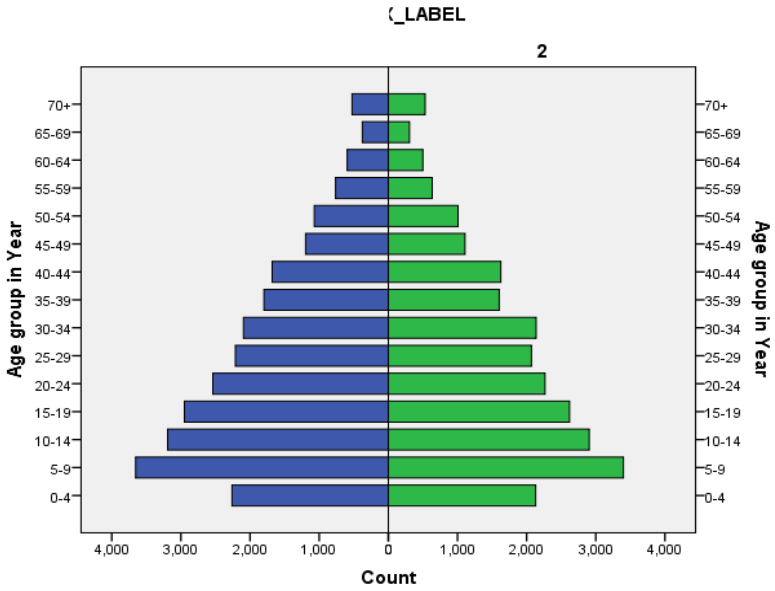


Figure 3-1 shows (i) the age and sex population structure of the population study in four iHDSS sites (Asaro, Hiri, Hides, and Karkar)[10] and (ii) the overall per site population trend. The population pyramid shows that the study population of the four iHDSS sites are very young, with longer bars at the bottom. The overall sex composition of the population is variable depending upon the specific age segment and iHDSS location. As previously noted in earlier PNGIMR biannual reports, the reasons for sex differences across different sites and ages is unclear and requires further evaluation. The overall population trend data shows some not unexpected variability. Which will be further discussed in the chapter on in/out migration.



[10] This population pyramid was built for four iHDSS sites based on a total population of approximately 54,000 recorded in the system by the end of March 2015. Some tables are updated with the most current 2015 data; hence there are some differences in population totals across tables depending upon which data set was utilized. This will be rectified in the final submission.

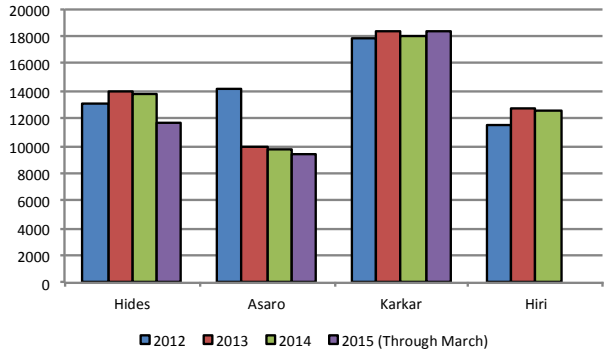


Figure 3-1 Population pyramid and Sequential population trend data of the study population, iHDSS sites 2015 (1: Male, 2: Female)

Table 3-2 shows (i) the 2015 population distribution by age group and sex of Asaro and the 2012-2015 sequential trend pyramids. The Asaro iHDSS covers 9,473people. Sex ratio of the whole population showed 107 males per 100 females. The sex ratios were relatively high among populations in age groups of 50-64. In contrast, the sex ratios were lowest in age group 30-34 and 40-49 (79-95 males per 100 females). The variations of sex ratios across age groups could have been biased, due to age and sex specific migration rates. The data suggested that females in age groups of 40-49 are more likely than male counterparts to migrate in Asaro. In contrast, there were more males in age group 35-39 than females of this age group being recorded in the system. Further analysis of the migration flows and reasons for migration could provide insights into this observation on the population pyramid of Asaro (**Figure 3-2**).

The working age population 15-64, accounts for 62.3% of the population in Asaro. Total dependency was 37.7%, with most (32.5 of the 37.7%) as child dependency and 5.2% as elderly dependency. The population is very young as reflected in the Population Ageing Index of 16%[11]. The population pyramid of Asaro show shorter bars of the population aged 0-4 at the bottom of the population pyramid, indicating a declined fertility over the last 4 years. This observation has been captured in Asaro iHDSS site in the last two years. That might require further investigation to better understand the phenomenon.

3.2 ASARO

Table 3-2 Population distribution by sex and age groups, Asaro, iHDSS, 2015

Age group	Male		Female		Total		Sex Ratio
	n	%	n	%	n	%	M:F
0-4	399	8.1	350	7.7	749	7.9	114:100

[11] PAI is measured by the ratio between proportion of the elderly aged 65+ and proportion of the children aged 0-14. Some countries calculate proportion of population aged 60+.

5-9	675	13.8	599	13.1	1274	13.4	113:100
10-14	542	11.1	518	11.3	1060	11.2	105:100
15-19	513	10.5	460	10.1	973	10.3	112:100
20-24	429	8.7	371	8.1	800	8.4	116:100
25-29	377	7.7	374	8.2	751	7.9	101:100
30-34	314	6.4	399	8.7	713	7.5	79:100
35-39	317	6.5	261	5.7	578	6.1	121:100
40-44	312	6.4	360	7.9	672	7.1	87:100
45-49	218	4.4	229	5.0	447	4.7	95:100
50-54	222	4.5	198	4.3	420	4.4	112:100
55-59	170	3.5	108	2.4	278	2.9	157:100
60-64	154	3.1	111	2.4	265	2.8	139:100
65-69	94	1.9	79	1.7	173	1.8	119:100
70+	168	3.4	152	3.3	320	3.4	111:100
Total	**4,904**	**100**	**4,569**	**100**	**9,473**	**100**	**107:100**

Age group	Male		Female		Total		Sex Ratio
	n	%	n	%	n	%	M:F
0-14	1,616	33.0	1,467	32.1	3,083	32.5	110:100
15-64	3,026	61.7	2,871	62.8	5,897	62.3	105:100
65+	262	5.3	231	5.1	493	5.2	113:100
Total	**4,904**	**100**	**4,569**	**100**	**9,473**	**100**	**107:100**

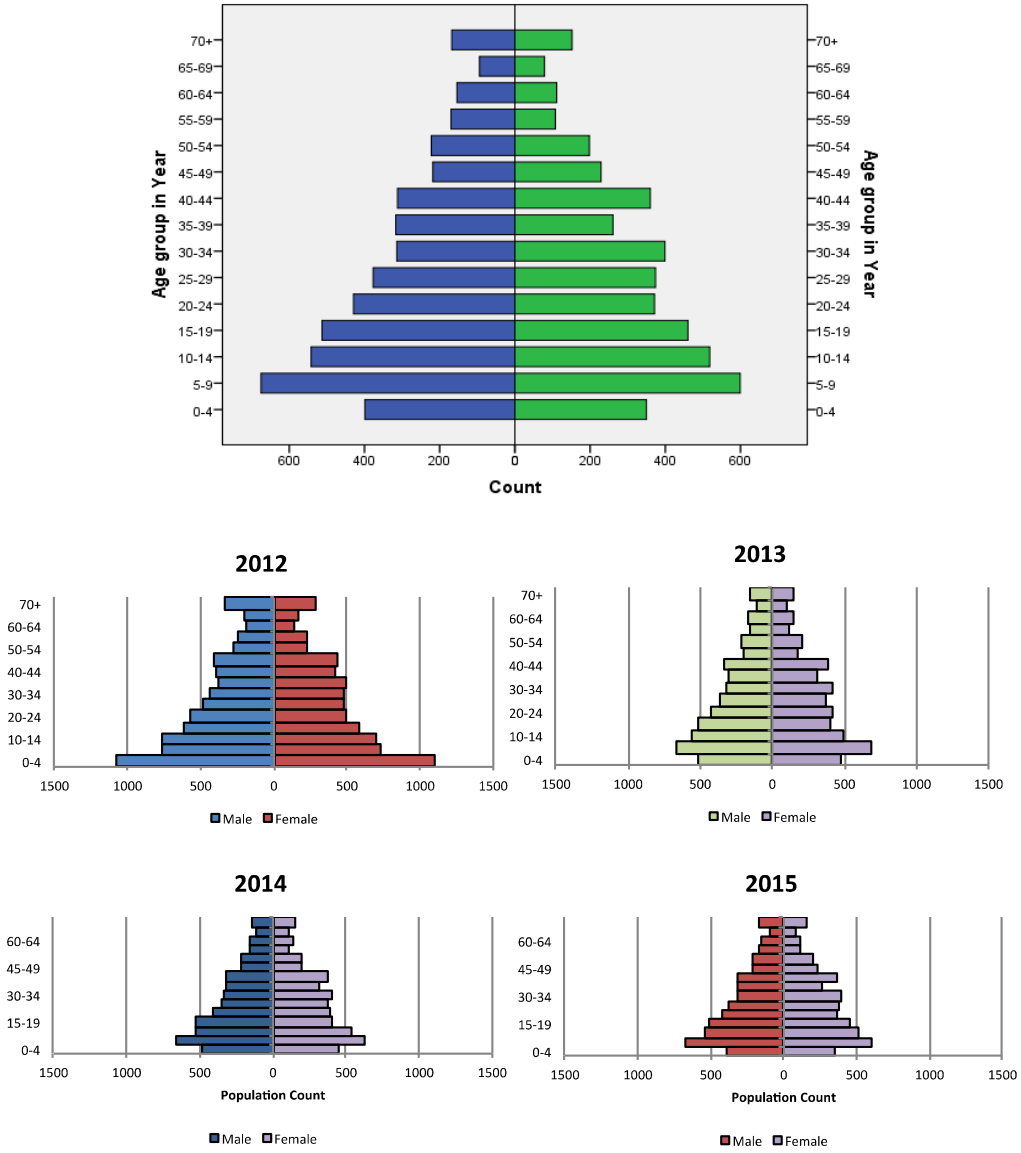


Figure 3-2 Population pyramid of Asaro, iHDSS, 2015 (1: Male, 2: Female) including longitudinal trends

3.3 HIDES

Table 3-3 shows the population data for Hides. Hides iHDSS recorded 11,758 people in the last update. The sex ratio is of 102 males per 100 females. The sex ratios tend to increase in higher age groups, i.e. age groups 55+. However, the population size of this age group is relative small and do not allow for further analysis of age-specific mortality rate which would be needed in order to identify the underlying cause for this observation. Both the 2015 population pyramid and the 2012-2012 sequential data are shown in Figure 3-5.

By contrast, differences in sex ratios are relatively low in age groups of 20-34. This could be biased due age and sex specific migration rates among these population groups. However, more in-depth analysis presented in the following chapter on migration will provide better understanding of this observation.

Table 3-3 Population distribution by sex and age groups, Hides, iHDSS, 2015

Age group	Male		Female		Total		Sex Ratio
	n	%	n	%	n	%	M:F
0-4	605	10.2	586	10.1	1191	10.1	103:100
5-9	763	12.8	768	13.2	1531	13.0	99:100
10-14	689	11.6	625	10.7	1314	11.2	110:100
15-19	658	11.1	582	10.0	1240	10.5	132:100
20-24	511	8.6	526	9.0	1037	8.8	97:100
25-29	497	8.4	513	8.8	1010	8.6	97:100
30-34	588	9.9	662	11.4	1250	10.6	89:100
35-39	461	7.8	445	7.6	906	7.7	104:100
40-44	443	7.5	446	7.7	889	7.6	99:100
45-49	261	4.4	208	3.6	469	4.0	125:100
50-54	193	3.2	178	3.1	371	3.2	108:100
55-59	113	1.9	82	1.4	195	1.7	138:100
60-64	64	1.1	90	1.5	154	1.3	71:100
65-69	41	0.7	45	0.8	86	0.7	91:100
70+	53	0.9	62	1.1	115	1.0	85:100
Total	**5,940**	**100**	**5,818**	**100**	**11,758**	**100**	**102:100**

Age group	Male		Female		Total		Sex Ratio
	n	%	n	%	n	%	M:F
0-14	2,057	34.6	1,979	34.0	4,036	34.3	104:100
15-64	3,789	63.8	3,732	64.1	7,521	64.0	102:100
65+	94	1.6	107	1.8	201	1.7	88:100
Total	**5,940**	**100**	**5,818**	**100**	**11,758**	**100**	**102:100**

The population pyramid of Hides is distorted as shown in

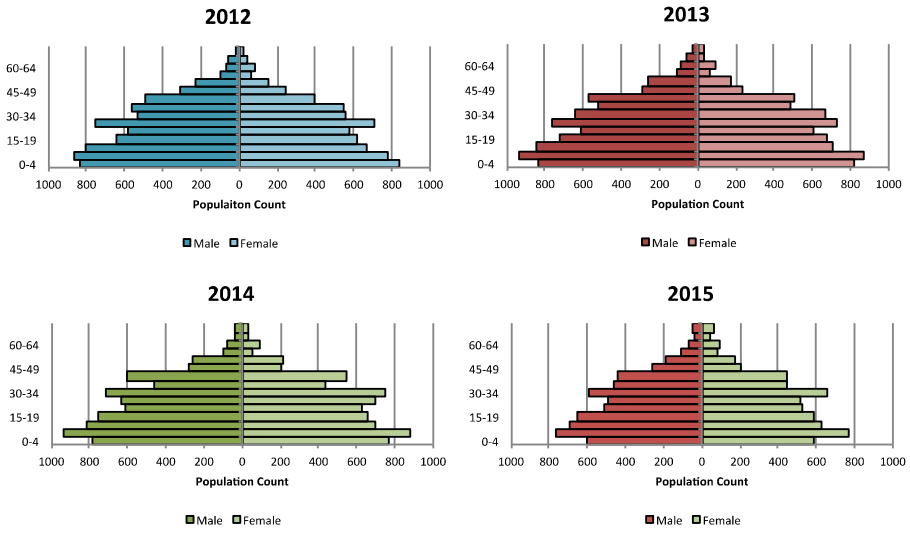
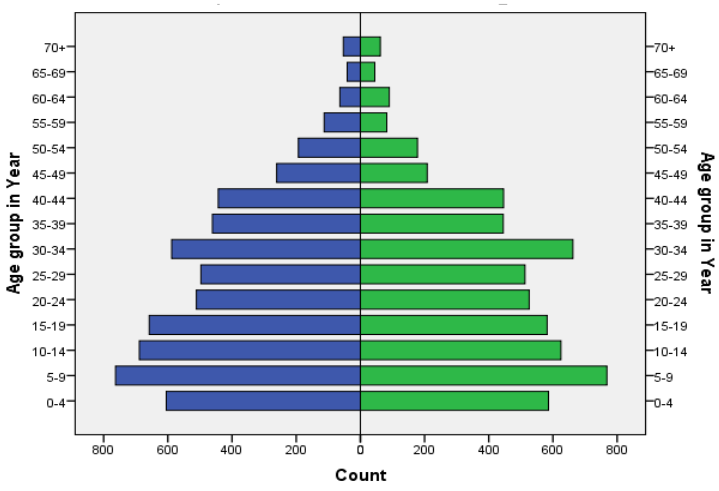


Figure 3-3, probably due to the migration flows as reflected in larger populations of working age, particularly 30-34. However, this hypothesis cannot explain the larger population of age group 30-34. This observation could be due to the selection of study population/site and/or the age specific in-migration rate could be playing a role. The shorter bar of population aged 0-4 is a result of apparent changes in fertility rates in Hides in the last few years.



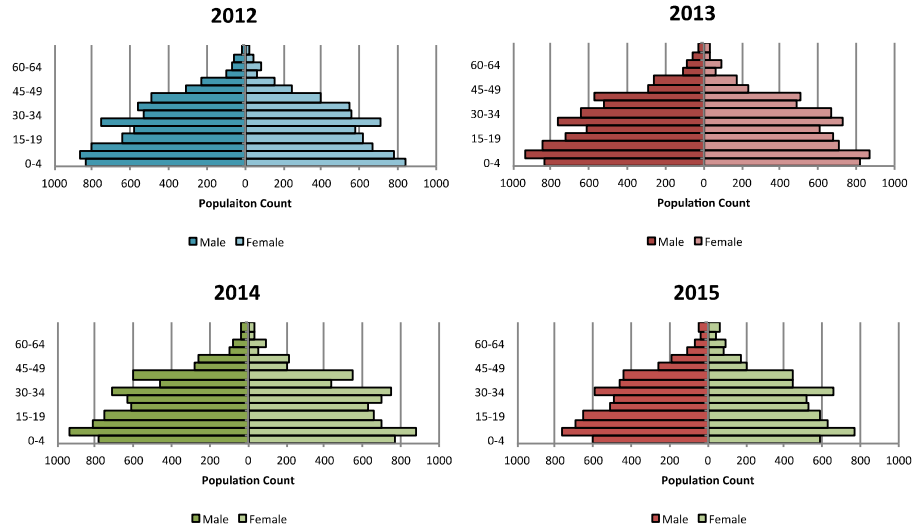


Figure 3-3 Population pyramid of Hides, iHDSS, 2015 (1: Male, 2: Female)

3.4 HIRI

Table 3-4 shows both the 2015 population distribution by age and sex in Hiri and the 2012-2015 sequential trends. A total population of 12,476 was recorded in the Hiri iHDSS by March 2015.Child dependency[12] was 34.1% and elderly dependency[13] was only 3.3%. Total dependency therefore, was only 37.4% of the population. Total dependency ratio[14] was 59.9%, meaning that there are approximately 60 dependants per every 100 working population. With such a low total dependency ratio, the Hiri has a significant potential labour force for socio-economic development in the coming years[15].

Table 3-4 Population distribution by sex and age groups, Hiri, iHDSS, 2015

Age group	Male		Female		Total		Sex Ratio
	n	%	n	%	n	%	M:F
0-4	619	9.8	597	10.4	1216	10.1	103:100
5-9	815	12.9	770	13.4	1585	13.1	106:100
10-14	694	11.0	619	10.7	1313	10.9	112:100

[12] Child dependency ratio is measured by the proportion of child population aged 0-14 per 100 population of working age.

[13] Elderly dependency is measured by the proportion of the population aged 65+ or moreper 100 population of working age.

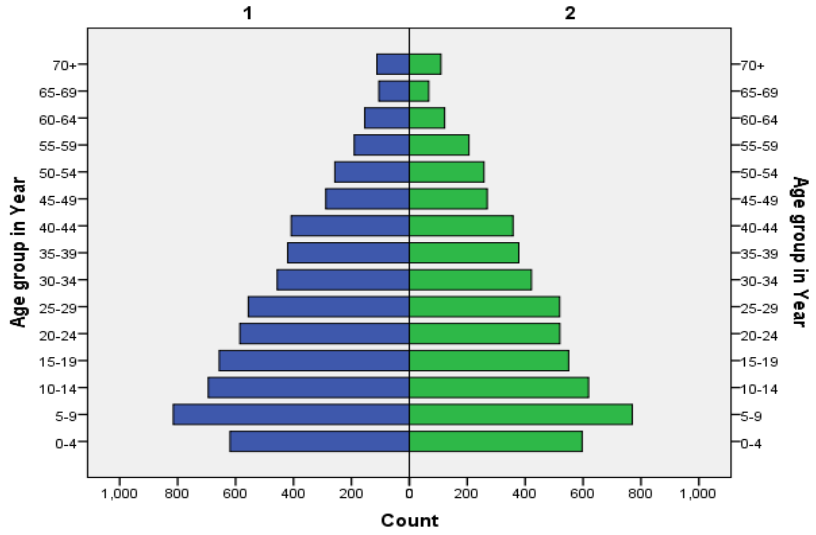
[14] Total dependency ratio is measured by the ratio between the total dependency and proportion of population of working age 15-64

[15]A population is conventionally considered as 'demographic dividends' if the total dependency of that population is equivalent or less than 50% of the population. In other words, there is only one dependant (or less) per each person of working age.

15-19	656	10.4	550	9.5	1206	10.0	119:100
20-24	585	9.3	520	9.0	1105	9.1	113:100
25-29	556	8.8	519	9.0	1075	8.9	107:100
30-34	456	7.2	422	7.3	878	7.3	108:100
35-39	420	6.7	378	6.6	798	6.6	111:100
40-44	408	6.5	358	6.2	766	6.3	114:100
45-49	288	4.6	269	4.7	557	4.6	107:100
50-54	257	4.1	258	4.5	515	4.3	100:100
55-59	190	3.0	206	3.6	396	3.3	92:100
60-64	154	2.4	122	2.1	276	2.3	126:100
65-69	105	1.7	67	1.2	172	1.4	157:100
70+	112	1.8	109	1.9	221	1.8	103:100
Total	**6315**	**100**	**5764**	**100**	**12079**	**100.0**	**110:100**

	Male		Female		Total		Sex Ratio
Age group	**n**	**%**	**n**	**%**	**n**	**%**	**M:F**
0-14	2,128	33.7	1,986	34.5	4,114	34.1	107:100
15-64	3,970	62.9	3,602	62.5	7,572	62.7	110:100
65+	217	3.4	176	3.1	393	3.3	124:100
Total	**6,315**	**100**	**5,764**	**100**	**12,079**	**100**	**109:100**

Figure 3-4 shows the population pyramid of Hiri. Hiri has a typical population pyramid of a young population. The base bar is consistent with the observation of 'baby boom' among children under 4 of age. The most current data indicates that there is a normal proportion of 20-24-age-group population, suggesting that there is minimal in-migration flow into Hiri. This observation is consistent with other overall population indicators of in/out migration



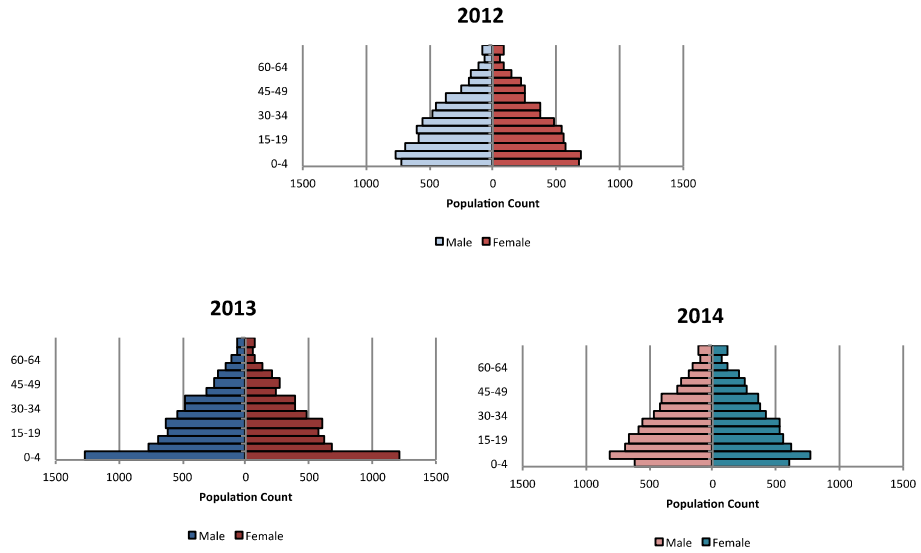


Figure 3-4 Population pyramid of Hiri, iHDSS, 2015 (1: Male, 2: Female)

3.5 KARKAR

Table 3-5shows the population distribution in Karkar. A total of 18,441 people recorded in the iHDSS in Karkar over the reporting period. The age structure of Karkar population is typical for a young population with the larger proportions of younger age groups and smaller proportions of higher age groups i.e. the proportion of population was highest at age group of 5-9 (14.4%) and declined gradually to 1% for the age group 65-69.

Sex ratio of the entire population of Karkar is high, i.e., 112 males per 100 females, 110/100 for children age 0-14, and 114/100 for population of working age 15-64. However, the sex ratio of the elderly population age 65+ was only 101/100. These data suggest a flow of female out-migration in Karkar. Further study on sex ratio of the population could provide more insights into this observation.

The population of working age accounted for 62.3% of the population, with a total dependency of 37.7% and a total dependency ratio of60.6%, i.e., there are only 61 dependents for every 100 people of working age. This dependency ratio (like Hiri) suggests that there is large potential labour force in Karkar.

Table 3-5 Population distribution by sex and age groups, Karkar, iHDSS, 2015

Age group	Male		Female		Total		Sex Ratio
	n	%	n	%	n	%	M:F
0-4	639	6.6	597	6.9	1236	6.7	107:100

5-9	1400	14.4	1262	14.5	2662	14.4	111:100
10-14	1268	13.0	1144	13.2	2412	13.1	111:100
15-19	1122	11.5	1028	11.8	2150	11.7	109:100
20-24	1014	10.4	849	9.8	1863	10.1	119:100
25-29	781	8.0	664	7.6	1445	7.8	118:100
30-34	738	7.6	654	7.5	1392	7.5	113:100
35-39	602	6.2	518	6.0	1120	6.1	116:100
40-44	516	5.3	463	5.3	979	5.3	111:100
45-49	429	4.4	402	4.6	831	4.5	107:100
50-54	400	4.1	375	4.3	775	4.2	107:100
55-59	290	3.0	239	2.7	529	2.9	121:100
60-64	223	2.3	177	2.0	400	2.2	126:100
65-69	135	1.4	115	1.3	250	1.4	117:100
70+	191	2.0	208	2.4	399	2.2	92:100
Total	**9,748**	**100**	**8695**	**100**	**18,443**	**100**	**112:100**

Age group	**Male**		**Female**		**Total**		**Sex Ratio**
	n	**%**	**n**	**%**	**n**	**%**	**M:F**
0-14	3,307	33.9	3,003	34.5	6,310	34.2	110:100
15-64	6,115	62.7	5,369	61.7	11,484	62.3	114:100
65+	326	3.3	323	3.7	649	3.5	101:100
Total	**9,748**	**100**	**8,695**	**100**	**18,443**	**100**	**112:100**

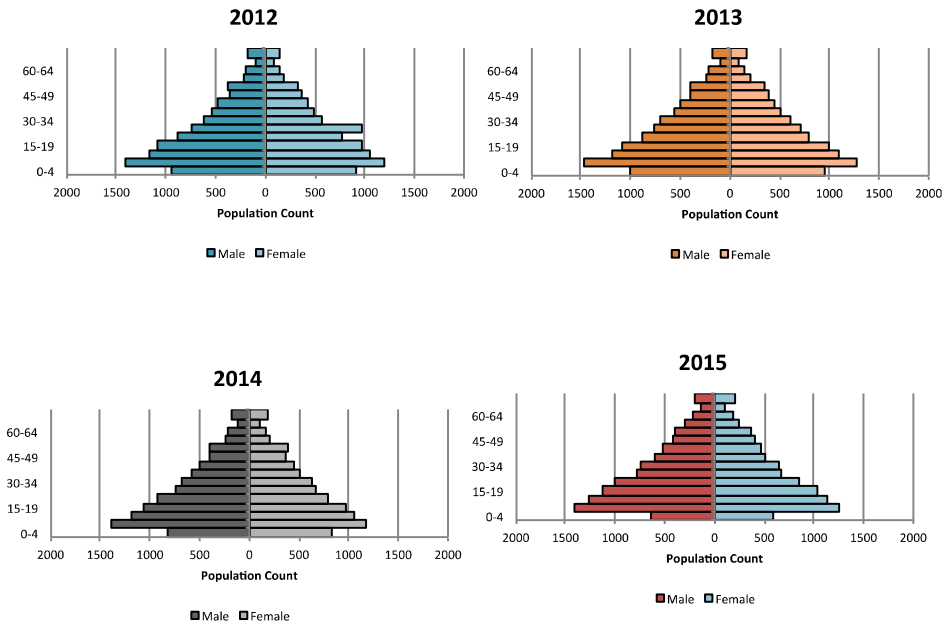


Figure 3-5 shows the 2015 population pyramid of Karkar and sequential 2012-2015 trend data. As these population pyramids illustrate, the overall structure is typical for a young population and

similar to that for the entire population of the four iHDSS sites. There is a markedly shorter bar of the children in age group 0-4, likely reflecting a recent sharp decline in fertility in Karkar.

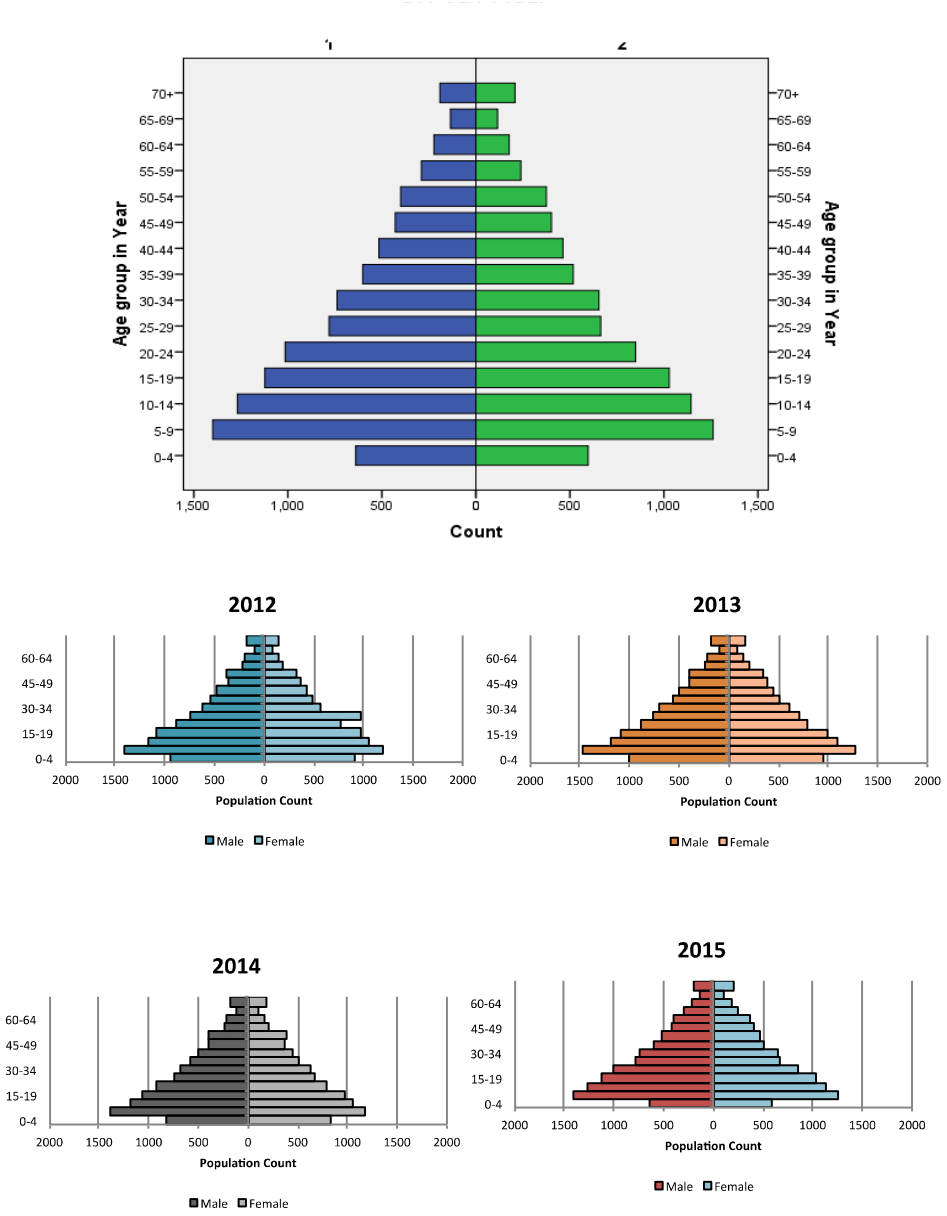


Figure 3-5 Population pyramid of Karkar, iHDSS, 2015 (1: Male, 2: Female)

4.0 MIGRATION AND HOUSEHOLD DISTRIBUTION

4.1 ABSTRACT

Using GPS data, Hides, Karkar and Asaro iHDSS population distribution and in/out migration were analysed. Hiri in/out migration data have been reported in a separate report and analysed in detail during a November/December 2014 fieldwork verification study and reported by PNGIMR in January 2015. Summary population data are presented in the January PNGIMR2015 "Hiri Field Verification Report;" therefore, these data not fully reproduced in this chapter; however, key results and observations are included in summary tables so that data from all four iHDSS locations are presented.

Similar to the finding from the in/out migration data of Hiri (which demonstrated modest net out migration), Asaro, Karkar and Hides experienced out-migration flows larger than in-migration as shown by Net Gross Migration Rates. Possible drivers of these new out-migration trends are unknown, but in both Hiri and Hides (Division 3) there may be some contribution associated with the recent demobilization of the PNG LNG Project activities as the active construction phase was largely concluded by the end of 2014. However, as discussed in subsequent sections of this chapter 'Marriage/family,' rather than employment, is the largest numerical driver of migration.

Interestingly, both Asaro and Karkar also reported larger migration flows out of the sites than in-migration. Migrants were most likely in working age, 15-64. There was no clear difference in sex of migrants; however, the most common reasons for both in and out migrations were 'Marriage / family affairs'. 'Work/employment' is often 'assumed' to be the reason for both groups of in and out migrants; however, it was not the strongest driver pushing people to migrate out or pulling people to migrate into the Hides, Asaro and Karkar iHDSS sites. This observation is also true for the Hiri iHDSS population.

Further monitoring of the migration trend is needed to confirm these initial observations.

4.2 MIGRATION RATES

Table 4-1shows the population migration rates of iHDSS, including in and out of the iHDSS sites. The INDEPTH's definition of migration (see footnote in chapter 2) was used in this analysis, wherein individual is considered a migrant if he/she moves across the boundary of an iHDSS site; hence, it means mobility of the population within an iHDSS site is not defined as migration. This is extremely important in Hides as the Huli frequently "circulate" within a wide geographical area, i.e., "the Division," and claim numerous residences, both permanent and temporary. Hulis are able to trace their genealogy on both their paternal and maternal lineages going back eight generations and so are able to move frequently in a circulatory manner within a specific geogprahical area and it is not unusual for them to have multi-local residences - both permanent or temporary.

Table 4-1. Migration Rates by site, iHDSS, 2015

		Asaro	Karkar	Hides	Hiri
	Population size	**9953**	**18623**	**13253**	**12,404**
In-migration	Number of In-migrants	81	4	153	285
	Crude In Migration Rate (%)	0.81	0.02	1.15	2.76
Out-migration	Number of Out-migrants	151	136	159	453
	Crude Out Migration Rate (%)	1.52	0.73	1.2	4.39
Gross Migration	Total of In and Out Migrants	232	140	312	738
(In-Migration + Out-Migration)	Crude Gross Migration Rate (%)	2.33	0.75	2.35	7.15
Net Migration	Net number of Migrants	-70	-132	-6	-168
(In-Migration – Out-Migration)	Crude Net Migration Rate (%)	-0.70	-0.71	-0.05	-1.62

Note: Hiri migration data was analysed in detail and submitted in a separate report by PNGIMR in January2015. An overall population summary is included in the May 2015 "Hiri Field Verification Study"

The results of migration data analyses showed three iHDSS sites had very low rates of migration i.e., the Crude Gross Migration Rates i.e.2.33% in Asaro, 0.75% in Karkar and 2.35% in Hides. The Crude Gross Migration Rate for Hiri was substantially higher (7.15%) The out-migration rates were relatively higher than the in-migration rates for all four iHDSS sites, resulted in the Crude Net Migration Rates at -0.7% in Asaro, -0.71% in Karkar and -0.05% in Hides, and negative (-)1.62% in Hiri meaning that the out-migration flows were relatively larger than the in-migration ones for all iHDSS sites in the reporting period.

Further analysis of in-migration by iHDSS site is presented in the following section.

4.3 In-Migration

Table 4-2 shows the distribution of in-migrants by age and sex in three iHDSS sites: Asaro, Karkar and Hides over the reporting period. Hiri is shown with summary data. Hides iHDSS recorded 107 people migrated into the site. The majority of in-migrants into Hides were of working age 15-64 (71) and female migrants were outnumbered of male counterparts, 46 compared to 25. Similarly, Asaro iHDSS recorded 78 in-migrants, of which 48 people were of working age 15-64 and 29 were females. Karkar iHDSS reported only one person migrating into the site in the reporting period. Hiri showed large numbers of individuals in both 0-14 and 15-64 age categories, potentially indicating movement of families.

Table 4-2 Distribution of In-migrants by age and sex, iHDSS site, 2015

Age of in-migrants	iHDSS site									
	Asaro			Karkar			Hides			Hiri
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Total
0-14	9	9	18	1	0	1	14	12	26	121
15-64	19	29	48	0	1	1	25	46	71	150
65+	8	4	12	0	0	0	4	6	10	1
Total	**36**	**42**	**78**	**1**	**1**	**2**	**43**	**64**	**107**	**272**

Table 4-3 presents the reasons for migration into the iHDSS sites: Asaro, Karkar and Hides over the reporting period. Summary data are shown for Hiri. For Asaro, 'other reasons' accounted for the majority of the responses, particularly in Hiri (n=61). It was followed by 'return to original place' and 'marriage/family affairs' reasons. It is noted that no one responded 'Job/employment' as reason for migrating into Asaro. Similar patterns of responses was also found among people who migrated into Hides over the reporting period with the majority moved to Hides as 'returning to original place' and 'Marriage/family affairs'. Only four responses were 'Job/employment' as reason for migration into Hides in the reporting period. Hiri responses demonstrate that “Marriage/family’ dominates the response pattern; however, there are a large number of ‘other’ responses. Therefore, these data should be cautiously interpreted and are under further investigation by the iHDSS team.

Table 4-3 Reasons for In-migration by sex of in-migrants and iHDSS site, 2015

Reasons for in-migration	iHDSS sites									
	Asaro			Karkar			Hides			Hiri
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Total
Work/employment	0	0	0	1	1	2	3	1	4	7
Education/training	1	3	4	0	0	0	2	3	5	5
Marriage/family affairs	9	21	30	0	1	1	14	30	44	119
Health/medical	0	0	0	0	0	0	1	0	1	n/a
Security/conflict	6	3	9	0	0	0	13	15	28	n/a
Return to original place	21	16	38	1	0	1	22	27	49	n/a
Others	37	43	81	0	0	0	4	4	8	61
Total	**74**	**86**	**162**	**2**	**2**	**4**	**59**	**80**	**139**	**192**

Table 4-4 shows the responses to the question of how long was the intention of stay among the people who migrated into two of the iHDSS sites. About one thirds of the responses (14 out of 43) of migrants into Hides were intention of stay for only one year. Five responses were for 2 years, fours were for three years, two for four years and four for 5 years and above. Fourteen responses were 'Don't know'. It was noted that most of all responses of migrants into Asaro (42/43) were 'Don't know' and there was no response being recorded in Karkar iHDSS site. These data are not available for Hiri.

Table 4-4 Intention of stay of in-migrants by sex and iHDSS site, 2015

Intention of stay in year	iHDSS site					
	Asaro			Hides		
	Male	Female	Total	Male	Female	Total
1 year	0	0	0	5	9	14
2 years	0	0	0	1	4	5
3 years	0	0	0	1	3	4
4 years	0	0	0	0	2	2
5 years+	0	1	1	2	2	4
DK	18	24	42	7	7	14
Total	**18**	**25**	**43**	**16**	**27**	**43**

4.4 Out-Migration

Table 4-5 shows the distribution of out-migrants by age and sex across three iHDSS sites over the last reporting period. Summary data are shown for Hiri. A total of 123 people migrated out of Asaro; the majority (101) were of working age, 15-64, males and females, 46 and 55, respectively. 106 out-migrants were recorded in Hides over the reporting period, of which 61 out-migrants were of working age, including 35 males and 26 females. There were 362 out migrants from Hiri dominated by the age 15-64 category.

Table 4-5 Distribution of Out-migrants by age and sex and iHDSS site, 2015

Age of out-migrants	iHDSS site									
	Asaro			Karkar			Hides			Hiri
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Total
0-14	2	9	11	4	5	9	13	9	22	115
15-64	46	55	101	36	41	77	35	26	61	215
65+	6	5	11	7	2	9	14	9	23	2
Total	**54**	**69**	**123**	**47**	**48**	**95**	**62**	**44**	**106**	**362**

Table 4-6 shows the reasons for people to migrate out of iHDSS sites over the reporting period. While the main reason for migrants to move out of Asaro was 'marriage/ family affairs', and more females than males reported this reason. 50% of the people who left Hides stated 'home return' as the primary reason, of whom, there were 40 males compared to 30 females. 16 people reported 'security/safety' as the reason for leaving Hides. 'Work/ employment' is also a factor to out migrate out from the sites, i.e., 21 people in Asaro, and 10 people in Hides. In Hiri, 'Marriage/family' dominates the responses; however, there were a large number of missing (193) and refusals (65); therefore, results should be interpreted cautiously.

Table 4-6 Reasons for Out-migrant by sex and iHDSS site, 2015

Reason for out-migration	iHDSS site									
	Asaro			Karkar			Hides			Hiri
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Total
Work/employment	13	8	21	11	4	15	7	3	10	13
Education/training	0	4	4	3	1	4	2	1	3	2
Marriage/family	16	31	47	14	29	43	10	11	21	119
Health/medical	0	1	1	0	1	1	4	3	7	
Security/conflict	5	10	15	1	0	1	9	7	16	
Return to original place	16	17	33	22	15	37	40	30	70	
Others	2	2	4	2	5	7	6	5	11	61
DK	4	3	7	3	5	8	3	1	4	
Total	**65**	**86**	**151**	**71**	**64**	**135**	**84**	**70**	**154**	

Table 4-7 shows the duration of time that people had stayed in the iHDSS site before they migrated out of the site over the reporting period. A number of respondents at the sites reported 'Don't know' for an answer. 14 out-migrants reported staying for 1 year and 5 reported staying for 2 years in Hides before they migrated out of this site. These data are not available for Hiri. The iHDSS team is working to improve data capture and quality for this exercise in future reports.

Table 4-7 Duration of stay of migrants before migrating out of iHDSS site, 2015

Duration of stay	iHDSS site								
	Asaro			Karkar			Hides		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
1 year	1	1	2	4	1	5	8	6	14
2 years	0	0	0	2	0	2	4	1	5
3 years	0	0	0	0	2	2	0	0	0
4 years	0	0	0	0	0	0	2	0	2
5 years	1	2	3	0	0	0	0	0	0
6 years	0	0	0	0	1	1	0	0	0
7 years	0	1	1	3	3	6	0	0	0
8 years	0	0	0	0	0	0	0	0	0
9 years	0	1	1	0	0	0	0	0	0
10 years	0	0	0	0	0	0	1	1	2
DK	20	24	44	4	1	5	15	6	21
Total	**22**	**29**	**51**	**13**	**8**	**21**	**30**	**14**	**44**

5.0 BIRTH AND DEATH RATES

5.1 ABSTRACT

The birth and death rates provide important information for public health decision makers in Papua New Guinea. This Chapter presents birth and death data collected by the iHDSS at the four sites.

Asaro recorded a Crude Birth Rate of 11.5 per thousand population; Hides crude birth rate of 17.7 per thousand population; Hiri Crude Birth Rate of 20.3 per thousand and Karkar Crude Birth Rate of only 8.2 per thousand in 2014.

Crude Death rates were Asaro 3.2 per 1000 population; Hides 2.4 per 1000, Hiri 0.9 per 1000, and Karkar 2.5 per 1000 population in 2014.

There are marked differences across the locations, particularly comparing the impact versus the comparison locations. The role of income, employment and access to health care could be important factors and require further analysis.

According to the National Health Plan 2011-2010, PNG had a high Crude Birth Rate of 32 per 1000 population, compared to Fiji, a generally comparable Asia-Pacific island, at 21 per 1000 population in 2006. The neonatal, infant and child mortality rates remain high across PNG in comparison to other Asia-Pacific countries.

5.2 BIRTH AND DEATH CERTIFICATES

Table 5-21 shows the number of children under 5 years of age and their birth certificate status recorded at the 4 iHDSS sites (Asaro, Hides, Hiri, Karkar) over the reporting period. Among 207 children under 5 recorded in the system, Hiri had 13 birth certificates among 87 children, accounted for 14.94%. Asaro recorded 2 children having birth certificates among 31 children, accounted for 6.45. Karkar recorded 5 out of 15 children having birth certificates, 33.33%. Interestingly, Hides recorded 36 children with birth certificates among 74 children under 5, accounted for 48.65%.It is clear that Hides had the significantly higher proportion of children under 5 years of age reported having birth certificates than the other three sites despite the fact that Hides is known to have a lower socio-economic development status than other sites. Asaro has the lowest proportion of children under 5 having birth certificates. The iHDSS team is further evaluating these data.

Table 5-1 Birth certificate among children U5 by site, iHDSS 2015

	iHDSS Site				Total
	Hiri	Asaro	Karkar	Hides	
Number of children U5 records	87	31	15	74	207
Having birth certificate	13	2	5	36	56
%	14.94	6.45	33.33	48.65	27.05

Table 5-2show the death certificate status among people who died in 2014 and were recorded in the iHDSS. There are differences in documentation across the sites although the overall numbers are small; hence, interpretation of these data should be cautiously made.

Table 5-2 Death certificates among deaths in 2014 by site, iHDSS 2015

	iHDSS site				Total
	Hiri	Asaro	Karkar	Hides	
Number of death records in 2014	11	32	46	32	121
Having death certificate	2	1	4	3	10
%	18.18	3.13	8.70	9.38	8.26

The registration of births and deaths is highly variable across the sites and likely reflects an overall PNG problem of capturing and recording vital statistics. The iHDSS is a critical resource for generating vital statistics data.

5.3 BIRTH AND DEATH RATES

Table 5-3 demonstrates the Crude Birth Rate, Crude Death Rate and the Net Natural Population Growth Rate in study sites in 2014 as recorded in the iHDSS over the reporting period. Hiri had the highest Crude Birth Rate, 20.3 per 1000 population, but the lowest Crude Death Rate, 0.9 per 1000 and as a result of this, it had the highest Net Population Growth Rate at 19.4 per 1000.

Table 5-3. Crude Birth Rate, Crude Death Rate and Net Natural Population Growth Rate by site, iHDSS, 2015

	iHDSS Site				
	Hiri	Asaro	Karkar	Hides	Total
Population	12510	9953	18623	13253	54339
Birth records	254	114	153	234	755
Crude birth rate (per 1000 population)	20.3	11.5	8.2	17.7	13.9
Death records	11	32	46	32	121
Crude death rate (per 1000 population)	0.9	3.2	2.5	2.4	2.2
Net natural population growth rate (per 1000 population)	19.4	8.2	5.7	15.2	11.7

By contrast, Karkar had lowest Crude Birth Rate, 8.2 per 1000 while the Crude Death Rate was relatively high, 2.5 per 1000. Consequently, Karkar had the lowest Net Natural Population Growth Rate, at only the level of 5.7 per 1000. Among the four iHDSS sites, Karkar recorded the lowest Crude Birth Rate and Natural Population Growth Rate.

For Hides the Crude Birth Rate was recorded at 17.7% and the Crude Death Rate was recorded at 2.4%o, while the Net Natural Population growth rate was 15.2%o. Looking at the four iHDSS sites, Hides recorded the second highest Crude Birth Rate, Crude Death Rate and Natural Population Growth Rate.

For Hiri, the data shows the Crude Birth Rate at 20.3%, and the Crude Death Rate was recorded at 0.9%, while the Net Natural Population growth rate was 19.4%. Among the four iHDSS sites, Hiri recorded the highest Crude Birth Rate, Crude Death Rate and Natural Population Growth Rate.

5.4 AGE-SPECIFIC FERTILITY RATE (ASFR)

Table 5-4showed the age-specific fertility rate (ASFR[16] per thousand women) by iHDSS site in 2014. For all four sites, the highest ASFR, 52.2% falls into the women age group of 25-29. However, the ASFR varied across the four sites. Hiri has the highest ASFR for women age groups of 20-24 and 25-29, 90.4 and 94.4, respectively. By contrast, Karkar had relatively low ASFR in these age groups, at only 16.5 and 28.6.

Table 5-4. Age-specific fertility rate (per 1000 women) by iHDSS site, 2015

Age group	Hiri	Asaro	Karkar	Hides	Total
15-19	32.7	4.3	4.9	3.4	10.3
20-24	90.4	45.8	16.5	28.5	41.0
25-29	94.4	45.5	28.6	44.8	52.2
30-34	61.6	42.6	16.8	33.2	35.6
35-39	60.8	23.0	11.6	40.4	33.1
40-44	08.4	2.8	2.2	42.6	14.8
45-49	3.7	4.4	0.0	14.4	4.5

5.5 AGE OF FATHER AT GIVING BIRTH

Table 5-5illustrates the age of fathers at the time their babies were born in iHDSS sites, which were recorded in the system over the reporting period. The modes of father age varied across the sites i.e. Asaro the mode was found between the ages of 35-39 (n=17), while the second mode was recorded between the ages of 25-29 (n=13).

For Hides the mode of father age was found between the ages of 30-34 (n=28) and the second highest reproductive age group was recorded in 40-49 (n=20). Interestingly, the findings in this study showed that the recent age group of women giving birth in Hides was 30-34, while the recent age group of men having babies was also 30-34. Both women and men in Hides iHDSS have the same age as the mother and father who had given birth to babies during that period of reporting.

[16]Age-specific fertility rate is measured by the proportion of number of live births per 1,000 women in a particular age group e.g. 20-24 in a given year.

Table 5-5 Age of father when having a newborn in 2014 by iHDSS, 2015

Age Group of Father	Hiri		Asaro		Karkar		Hides		Total	
	N	%	N	%	N	%	N	%	N	%
15-19	1	0.73	0	0.00	0	0.00	1	1.03	2	0.59
20-24	28	20.44	6	10.71	8	15.69	3	3.09	45	13.20
25-29	42	30.66	13	23.21	9	17.65	8	8.25	72	21.11
30-34	27	19.71	12	21.43	8	15.69	28	28.87	75	21.99
35-39	17	12.41	17	30.36	15	29.41	14	14.43	63	18.48
40-44	19	13.87	3	5.36	7	13.73	17	17.53	46	13.49
45-49	2	1.46	3	5.36	2	3.92	20	20.62	27	7.92
50+	1	0.73	2	3.57	2	3.92	6	6.19	11	3.23
Total	**137**	**100**	**56**	**100**	**51**	**100**	**97**	**100**	341	**100**

For Hiri, the age of father at giving birth, the highest reproductive age group was found between the ages of 25-29 (n=42). While the second highest reproductive age group was recorded in 20-24 (n=28). For the Hiri iHDSS, age 20-29 is the dominant "parent" age interval. These data are consistent with known cultural patterns, i.e., Hides men tend to marry later while Hiri men tend to marry very young.

The highest reproductive age group for fathers in Karkar is ages 35-39 (n=15). While the second highest reproductive age group is 25-29 (n=9).

5.6 CHILD MORTALITIES

Table 5-6 illustrates child mortalities, including Children under-5 mortality, Infant mortality and Neonatal mortality in iHDSS sites over the reporting period. For Children U5, the death rate was 151 per 1000 live births. For the Infant mortality rate was 61 per 1000 live births. And for the Neonatal mortality, the death rate was 54 per 1000 live births.

The data analysis revealed that Asaro site had the highest rates of child mortalities, with Children U5 mortality rate at 473 per 1000 live births and Infant mortality rate at 210.53 per thousand live births and Neonatal death rate was of 201.75 per 1000 live births in 2014. By contrast, death data of Hiri showed considerable low levels i.e. Children under-5 mortality ratio at 35.43 per 1000 live births, IMR at 15.75 per 1000 live births, and Neonatal mortality at 15.75 per 1000 live births in 2014.

It is noted that the Child mortalities were reported for the first time by the iHDSS. Since the scope of child mortality data was small, it requires cautious to interpret these findings.

Table 5-6. Child mortality rates by iHDSS sites, 2015

	Hiri	Asaro	Karkar	Hides	Total
Total number of live births	254	114	153	234	755
Total deaths U5	9	54	17	34	114
Children U5 mortality rate (per 1000 live births)	35.43	473.68	111.11	145.30	150.99
Total infant deaths	4	24	7	11	46
Infant mortality rate (per 1000 live births)	15.75	210.53	45.75	47.01	60.93
Total neonatal deaths	4	23	7	7	41
Neonatal mortality rate (per 1000 live births)	15.75	201.75	45.75	29.91	54.30

6.0 MORBIDITY

6.1 ABSTRACT

At each iHDSS site clinics are staffed by nurses who record visits by patients and collect diagnostic data. All major clinics in the study areas are included and reported data with the exception of Porebada clinic (Hiri) which was non-compliant. Porebada is a provincial government run clinic that has a history of staffing difficulties, support and closures.

Results should be cautiously interpreted as some clinics have faced significant challenges in collecting and compiling data. Furthermore, in some locations patients may bypass health clinics and sub-health clinics and go directly to nearby hospitals.

Key findings from the preliminary data indicate that high levels of respiratory cases are presenting at local clinics. Skin diseases and diarrhea also contribute heavily to the clinical caseloads at most sites. These results were consistent with previous observations made in earlier PNGIMR reports.

6.2 ASARO

The 2015 March Report morbidity data from health facilities in Asaro iHDSS is incomplete. Preliminary morbidity data have been collected from three clinics, *Asaro*, *Tafeto* and *Kwongi* health centres. Data for *Uritoka* clinic was not included in this reporting period due to the closure of the health facility by the end of 2014. The total number of visitors to Asaro and Tafeto sub-health centre increased drastically for this reporting period compared to the previous period, suggesting an increased demand for healthcare and a potentially an over-burdened health service.

As shown in **Table 6-1**, Asaro clinic recorded high levels of respiratory, skin and diarrheal diseases in its health facilities. Records of cases visiting Asaro health facilities due to non-communicable diseases are relatively low or none, which likely reflects lack of experience with these diseases, i.e., clinical recognition. In addition, the number of men seen in local clinics tends to be markedly less than women so a major sex bias is introduced, i.e., fewer men who typically have greater rates of NCDs than women. Morbidity data collection is ongoing with further emphasizes on good record keeping by research nurses.

Unlike other health facilities, Tafeto sub-health centre recorded an increase in the number of caseloads for the current the reporting period compared to the other health centres in the site. This clinic also diagnosed high numbers of suspected measles in the July 2014 period. This has triggered massive measles immunization coverage (4,038) for communities around Tafeto sub-health centre as noted in the table above. Tafeto health centre is run by the Catholic Church and does not provide family planning services, only offering limited sexual health consultations. As a result, none or low case loads for family planning (FP) and STI were recorded in this clinic. Hence, this bias toward under reporting likely does not reflect the high prevalence of STI at the site that was clearly observed by the PNGIMR “Healthy Pregnancy Study.”The Tafeto health centre recorded an increase number of antenatal visits during the reporting period due to the antenatal awareness/campaign conducted by nurses in the surrounding villages.

Table 6-1 Cases load and provision of health services, Asaro iHDSS, July – Dec 2014 and Jan - March 2015

	Asaro	Kwongi	Tafeto	Total
Case Load	1,790	940	3,608	6338
Antenatal Visits	444	462	2,156	3062
Family Planning	518	106	NA	624
Immunisation	883	652	4,038	5573

Table 6-2 shows the percentage of various diseases recorded in three health centres in Asaro site in the reporting period. The data for the three Sub-Health Centres demonstrates high rates of skin infections, respiratory diseases and diarrheal diseases, but lower rates sexually transmitted infections (STI) and malaria. Asaro and Tafeto sub-health centres have no records of Tuberculosis (TB) during the reporting period. This finding could be due to the nurses not filling the tallies in the study forms or misdiagnosis of the presenting disease. Skin infections and respiratory diseases continue to have high reported "rates," i.e., percentages of total visits and/or diagnoses made. As expected, the morbidity cases for "other infections" were relatively high as it included other common diseases on the standard PNG national reporting form.

Asaro and Tafeto health centres recorded the highest number of cases, as the proximity to the main national highway makes for easy patient access. Kwongi health centre is located further in the interior and more difficult to access.

Table 6-2 Morbidity records in Health Centres in Asaro iHDSS, July – December, 2014 and Jan-March, 2015

	Asaro		Kwongi		Tafeto		Total	
	Number	%	Number	%	Number	%	Number	%
TB	0	0	20	1.47	0	0	20	0.24
STIs	0	0	28	2.06	16	0.37	44	0.53
Skin infections	350	13.73	103	7.56	44	1.02	497	6.04
Respiratory diseases	294	11.53	117	8.59	201	4.65	612	7.43
Antenatal care	444	17.42	462	33.92	2,156	49.9	3,062	37.2
Suspected Measles	2	0.08	8	0.59	44	1.02	54	0.66
Diarrhea	160	6.28	72	5.29	230	5.32	462	5.61
Malaria	68	2.67	25	1.84	3	0.07	96	1.67
Other infections	1,231	48.29	527	38.69	1,627	37.65	3,385	41.12
Total	**2,549**	**100%**	**1,362**	**100%**	**4,321**	**100%**	**8,232**	**100%**

6.3 HIDES

Table 6-3 showed the caseload recorded in Para and Mananda Clinics in the Hides iHDSS catchment area over a four-month period of November 2014- February 2015 (Para Clinic) and over a six-month period for Mananda Clinic (July-December 2014. Para clinic recorded 741 cases (185 cases/month) while Mananda recorded 834 cases/months The Para Clinic figures are lower than their historic 2010-2014 trend that was typically between 200-300 visits/month. The rapid PNG LNG demobilization in Hides is a potential driver; however, the monthly census levels at Mananda are somewhat higher than their usual monthly trend that was between 500-700 visits/month over a 2011-2014 time period. The Mananda Clinic is better staffed and equipped than Para Clinic and some level patient load shifting may be occurring.

Table 6-3: Case load recorded at Para clinic in Hides iHDSS, mid-Nov- 2014 –mid March 2015; Mananda Clinic

	Para
Total Case load	741
Respiratory	322
Diarrhea	119
"Other" Infections	154

Mananda Clinic July-December 2014 (total case load 5009)

	N	%
Accidents	133	2.7
Diarrhea	491	9.8
Malaria	51	1.0
Other Infection	2625	52.4
Respiratory	1289	25.7
Skin Infection	296	5.9
STIs	124	2.5

Table 6-4 shows the morbidity records for Para clinic (Mananda clinic is shown in Table 6-3. Respiratory diseases dominated the morbidity tallies in Hides clinics in the previous report, followed by diarrhea and skin disease. The category "other infections" is extremely large at both clinics and reflects both the ability of local staff to diagnosis patients and the national health information recording tally sheet that must be completed by all clinics in PNG.

Table 6-4 Morbidity records in Health Centres, Hides iHDSS, Nov 2014 -Feb 2015, Para Clinic- Nov 2014- Feb 2015

	Para Clinic	
	Number	**%**
Accident or Injury	52	7.02%
Diarrhea	119	16.06%
Malaria	5	0.67%
Other Infectious Diseases	0	0.00%
Other –Non described (includes oral health, eye/ear infection)	154	20.78%
Other Non-Communicable Diseases	2	0.27%
Respiratory Diseases	322	43.45%
Skin Diseases	73	9.85%
STIs	14	1.89%
TB	0	0.00%
Grand Total	741	100.00%

6.4 HIRI

Table 6-5shows the number of caseload recorded in two health centres: Papa and Boera in Hiri iHDSS site in 2015. Data from Porebada health centre was not included in this report because the clinic staff refused to provide data. Papa clinic has relatively high caseload compared to that of Boera clinic. This is because the health worker in Boera clinic was on leave during the months of October and November, thus reporting data is for December 2014 and January 2015 only. Papa clinic has high number of antenatal visits and immunisations recorded while Boera clinic has no data recorded because the health worker was on leave and no antenatal and immunisation activity was conducted for the tallied months.

Table 6-5 Case load at health clinics, Hiri iHDSS, Nov – Dec 2014 and Jan – Mar 2015

	Papa	Boera	Total
Case load	2330	459	2789
Antenatal visits	415	0	415
Family Planning	93	74	167
Immunisation	748	0	748

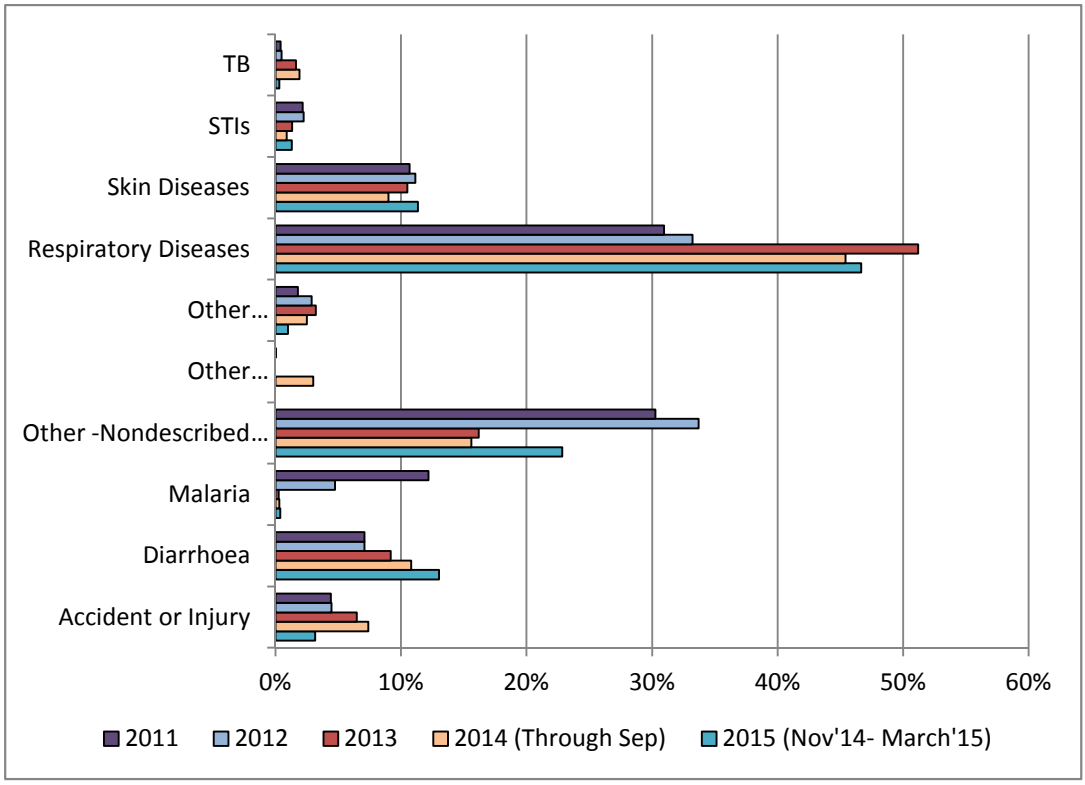
Table 6-6shows the number and proportion of diseases recorded in Papa Health Centre and Boera Health centre in Hiri for the reporting period July - 2014 - March 2015. The 2nd graph illustrates the historic trend at Papa Clinic. Papa clinic is the largest and best staffed and equipped clinic in Hiri. Diarrhea, skin respiratory infections and "Other- non-described dominate the tallies reported in these clinics. The pattern is quite similar to Hides.

TB, STI and RDT + malaria were recorded at very low levels, suggesting low presentation of patients seeking for treatment of these diseases at the two clinics. However, as shown in the PNGIMR TB study, the burden of TB in Hiri is significant and is simply not being captured by local clinics and/or patients are being seen in Port Moresby.

Table 6-6 Morbidity records in Health Centres, Hiri iHDSS, Nov-Dec 2014 and Jan-Mar 2015

	Papa Clinic		Boera Clinic		Total	
	n	%	n	%	n	%
Accident or Injury	73	3.1%	10	2.2%	83	3.0%
Antental	13	0.6%	0	0.0%	13	0.5%
Diarrhea	302	13.0%	73	15.9%	375	13.4%
Malaria	9	0.4%	135	29.4%	144	5.2%
Other Infectious Diseases	0	0.0%	0	0.0%	0	0.0%
Other-Nondescribed (includes oral health, eye/ear infection)	529	22.7%	85	18.5%	614	22.0%
Other Non-Communicable Diseases	23	1.0%	0	0.0%	23	0.8%
Respiratory Diseases	1081	46.4%	104	22.7%	1185	42.5%
Skin Diseases	263	11.3%	45	9.8%	308	11.0%
STIs	30	1.3%	7	1.5%	37	1.3%
TB	7	0.3%	0	0.0%	7	0.3%
Grand Total	**2330**	**100.0%**	**459**	**100.0%**	**2789**	**100.0%**

Historic Patient Caseload trend- Papa Clinic 2011-2015



6.5 KARKAR

Like other iHDSS health facilities, Karkar have faced many challenging situations in collecting, compiling, and reporting the data. As such, the preliminary results presented here were interpreted with some caution.

Table 6-7shows morbidity statistics collected from four health facilities in Karkar iHDSS site for the first two months of 2015. The preliminary figures in these tallies show that most patients visited the health centres for respiratory, followed by skin infections and "malaria."There were no records of immunization in all the facilities in Hiri. One of the reasons was that the Officers in charge of the clinics were reluctant to provide data to the research nurses. Some of the clinical nurses working in those health facilities were still on leave vacation (holidays); hence, the facility was operated with skeletal staffs with the high likelihood of incomplete charting and record keeping. Karkar data collection methods are currently ongoing revision and re-evaluation.

Table 6-7 Total number of cases load at health clinics, Karkar iHDSS, Jan – Feb 2015

	Gaubin	Kulubob	Miak	Mapor	Total
Case load	177	380	1,115	569	2,241
Antenatal and FP	34	NA	NA	119	153
Immunisation	NA	NA	NA	NA	NA

Table 6-8 compares morbidity data collected among patients in three health facilities in Karkar for the first two months of 2015. The data reported in this table are preliminary and indicates that respiratory diseases (32.97%); skin infections (13.93%) and malaria (11.72%) are the leading burdens of diseases recorded in nearly all the facilities. The trend of respiratory disease and skin infections were similar when compared with cases in other facilities in other iHDSS sites. Malaria was primarily clinically based, rather than consistently utilizing lab-test (RDT) confirmation. Without confirmation by rapid diagnostic test (RDTs) kits, many of these "malaria cases" are more likely respiratory infections. There were no reports of NCDs in all the facilities in the first two months of 2015. Non-availability of diagnostic equipment and lack of experience with NCDs is likely a problem.

Table 6-8 Morbidity records in Health Centres, Karkar iHDSS, Jan-Feb 2015

	Kulubob clinic		Miak clinic		Mapor clinic		Total	
	N	%	N	%	N	%	N	%
TB	0	0	8	0.85	0	0	8	0.46
STIs	4	1.41	6	0.64	0	0	10	0.58
Skin infections	60	21.20	126	13.39	54	10.82	240	13.93
Respiratory diseases	81	28.62	326	34.64	161	32.26	568	32.97
Antenatal care	0	0	NA	0	45	9.02	45	2.61
NCDs	0	0	0	0	0	0	0	0
Diarrhea	11	3.89	33	3.51	5	1.0	49	2.84
Malaria	25	8.83	88	9.35	89	17.84	202	11.72
Other infections	102	36.04	354	37.62	145	29.06	601	34.88
Total	**283**	**100%**	**941**	**100%**	**499**	**100%**	**1, 723**	**100%**

7.0 CAUSES OF DEATH

7.1 ABSTRACT

This chapter presents an updated summary of key findings from the cause of death study, using the Population Health Metrics Research Consortium (PHMRC) Verbal Autopsy instrument to follow up on deaths in the iHDSS sites. Here we present all deaths, reviewed by a physician and ascribed a probable cause of death as a preliminary analysis of the cause-specific mortality trends. Ascribing the probable cause of death can be an iterative process whereby further information can be sought from the interviewee or from hospital records that may be collected retrospectively. A senior physician performs ongoing reviews; hence, diagnoses may change over time.

Findings from this analysis continue to build the evidence for an epidemiological transition from a mortality structure dominated by infectious diseases to one where deaths are largely caused by non-communicable diseases (NCD). This transition is likely to continue and progress at different rates across the country. While many of these diseases, such as cardiovascular diseases and diabetes, are indicative of a change in lifestyles, other conditions most like chronic obstructive pulmonary diseases and asthma, likely due to indoor air pollution, significantly contribute to this burden in some locations. Of all the sites presented here, Hiri is the most developed population in terms of urbanisation and exhibits the highest rates NCDs. This is particularly evident when chronic obstructive pulmonary disease is excluded from the analysis in other sites. This data supports the recommendation for community-based public health NCD intervention programs across all sites and in Hiri in particular. This should be a high priority provincial and national health department priority.

Mortality surveillance data from the Hides iHDSS is currently incomplete and interpretation of cause of death results must be conducted with caution. The small numbers of deaths collected thus far, however, reveal emerging mortality patterns dominated by HIV/AIDS and homicide. Further research is recommended to better understand the social determinants in Hides that may be contributing to these deaths.

7.2 BACKGROUND

Most deaths in the Pacific region are not medically certified. Causes of death data are crucial for informing policy debates about priorities to reduce premature mortality and improve population health. In the absence of routine medical certification of deaths, Verbal Autopsies (VAs) are the only proven means of providing reliable data about COD patterns at the population level. Previous reports have described the verbal autopsy instrument and methodology in detail. Here we use the Population Health Metrics Research Consortium (PHMRC) VA instrument to follow up on deaths in iHDSS. VAs is routinely used in Demographic and Health Surveillance Systems around the world such as the International Centre for Diarrheal Disease Research, Matlab site in Bangladesh and the KEMRI/Centre for Disease Control (CDC) site in Kenya.

The aims of the Partnership in Health Project (PiHP) are to compare changes over time in two impact sites where the PNG-LNG project is active (Hides in Hela Province and West Hiri in Central Province) and two comparison sites (Asaro in the Eastern Highlands Province and Karkar an island that is part of Madang Province). The cause of death study aims to provide the following to the PiHP:

- To follow up on every reported death in the iHDSS and where –possible conduct a verbal autopsy interview with a relative of the deceased;
- To assign a probable cause of death to each death using physician review

This chapter presents total number of deaths as recorded in the iHDSS over the reporting period, as well as the results of preliminary analyses of specific causes of deaths, which were reviewed and verified by qualified and trained physicians taking part in the PiHP. As the numbers of deaths recorded in each year in the study site are relatively small, the presented analyses are longitudinally shown as all years combined.

7.3 METHODS

Households in the iHDSS are followed up every three months by local reporters. During these visits the reporters record any in or out migrations, pregnancies, births and deaths. Identified deaths are listed and given to the verbal autopsy team. Trained field staff coordinates with reporters to arrange a household visit at a time and location that suits the respondent. The interviews usually take place soon after the mourning period has come to an end. VA interviews can be emotional. After consent is obtained the respondent is ensured that they can stop the interview at any time and it is their choice to resume it at another time if they wish.

We have employed the Population Health Metrics Research Consortium (PHMRC) VA instrument in this study. Aside from asking questions about the signs and symptoms the deceased experienced prior to death, the standardised questionnaire also collects information on basic demographic and socio-economic covariates as well as some health care utilisation data. VA interviewers also ask to see and copy any information on health records that might be available. All VA forms are checked by independent members of the VA team for accuracy and consistency. Any forms with problems are sent back to the field for correction prior to data entry. VA forms, and where possible any health records included with the form, are then reviewed by a trained physician who ascribes a probable cause of death.

Causes of death were coded according to the International Classification of Disease-10. The VA forms are then entered into an Access database. Data analyses were conducted using SPSS Statistics 20. The VA data collected will also be analysed using computer-based analytical software developed at the Institute of Health Metrics and Evaluation (IHME) in Seattle and results will be compared with those of the physicians.

7.4 RESULTS

Table 7-1 showed that up to date, 1,487 verbal autopsies have been conducted on deaths from the four iHDSS sites by March 2015. Of these a total of 1,437 (96.6%) have been reviewed by the PiHP physician and have been assigned a probable cause of death.

Table 7-1 Physician reviewed verbal autopsies by site, iHDSS 2015

iHDSS site	Asaro		Hides		Hiri		Karkar		Total
	n	%	n	%	n	%	n	%	n
VA completed	652	43.8%	165	11.1%	305	20.5%	365	24.5%	1,487
COD completed	614	42.7%	162	11.3%	300	20.9%	361	25.1%	1,437

VA Verbal Autopsy
COD Cause of death

Table 7-2shows the distribution of deaths analysed by VA for which a year of death is available. The death data were collected by the iHDSS and presented over the last six years. In order to capture all deaths, during the first census at each site reporters asked if any deaths had occurred in the households since the first of January 2010. In most locations the collection of deaths began before the demographic surveillance officially commenced. The verbal autopsy project started in Hiri a number of months before the demographic surveillance; hence, verbal autopsies were conducted on deaths beginning in 2009.

Table 7-2 Number of deaths collected by year of death and site[17]

	Asaro	Hides	Hiri	Karkar	Total
2009	0	0	13	0	13
2010	57	3	59	49	168
2011	212	5	69	60	346
2012	211	56	69	122	458
2013	132	72	68	98	370
2014	40	29	27	36	132
Total	**652**	**165**	**305**	**365**	**1,487**

Table 7-3 showed the numbers of deaths that have been reviewed by physician and distributed across age groups in each of the iHDSS sites. On average 78% of deaths collected from each site are adults and about 14% are children and 8% are neonates. The numbers of deaths collected from Hides are relatively smaller than that of other sites. However, death data in Hides and Karkar indicates a greater proportion of deaths in neonates and infants (under one year of age).

Table 7-3Distribution of deaths by site and age, iHDSS, 2015

	Asaro		Hides		Hiri		Karkar		Total	
Age group	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Adults 15+	527	80.8	103	62.4	257	84.3	278	76.2	1165	78.3
Children 0-14	68	10.4	58	35.2	30	9.8	47	12.9	203	13.7
Neonates	57	8.8	4	2.4	18	5.9	40	10.9	119	8.0
Total	**652**	**100%**	**165**	**100%**	**305**	**100%**	**365**	**100%**	**1487**	**100%**

[17] Slight changes in numbers over analyses may result from on-going data cleaning efforts

Figure 7-1 presents the proportion of deaths by site and the different major groups of diseases: infectious diseases, non-communicable diseases (NCD), injuries and violence, maternal deaths and neonatal deaths. Those deaths for which no cause of death could be assigned are known here as indeterminate. Amongst adults, there were more male deaths in all disease groups except for infectious diseases in Hiri where females and males make up almost equal proportions. Equal numbers of males and females were represented amongst neonatal deaths in Hides and Karkar but in both Hiri and Asaro males made up more than 60% of neonatal deaths.

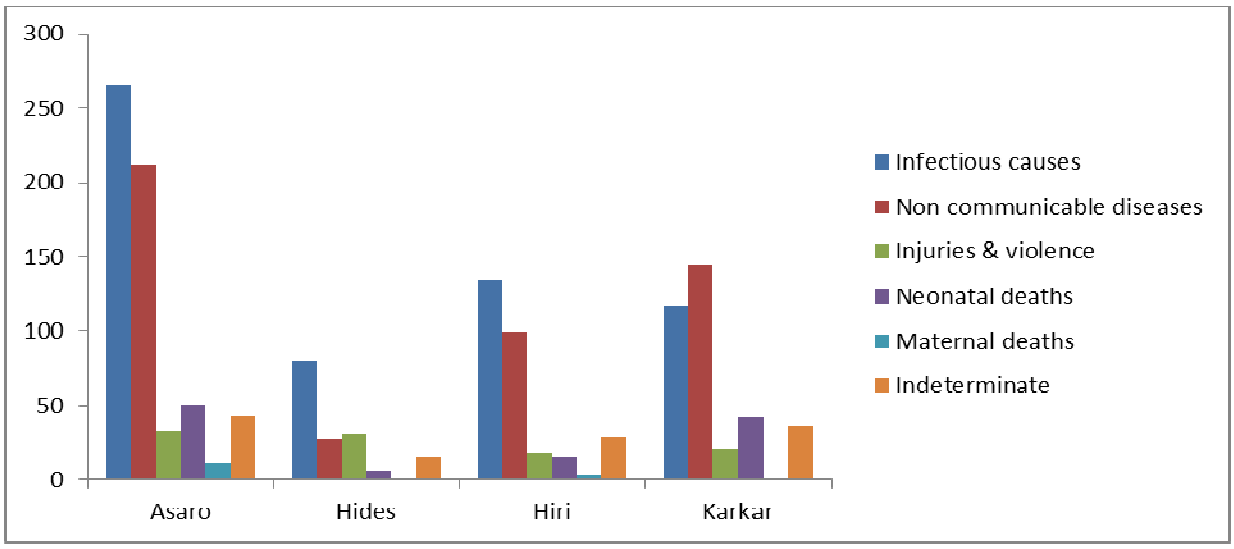


Figure 7-1 Probable cause of death (main groups of diseases) by iHDSS site[18], 2015

The overall mortality patterns by site have not changed substantially. Hides iHDSS continues to demonstrate a mortality pattern dominated by infectious diseases, which make up almost 50% of deaths in that population. The majority of deaths in Asaro and Hiri are also infectious in nature but non-communicable diseases like cardiovascular diseases and cancers are a very close second. A majority of deaths in Karkar were due to non-communicable diseases making up 40% of the total deaths with no maternal deaths at all. Injuries and violence continue to be the cause of an especially high number of deaths in Hides, reaching almost 20% of all deaths. The previous report presented leading causes of death by site.

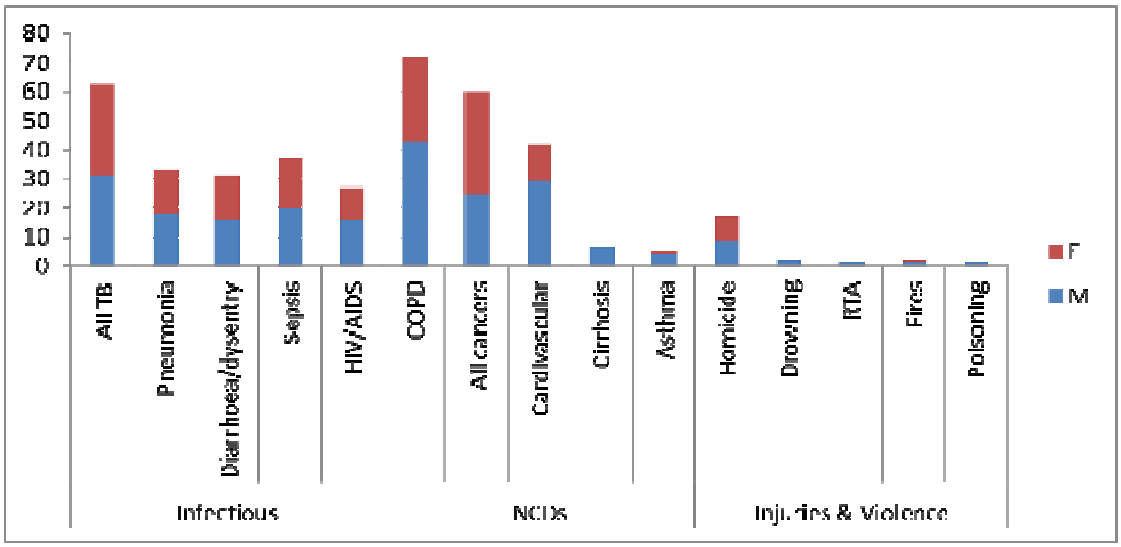
7.5 ADULT LEADING CAUSES OF DEATH

7.5.1 Asaro

Chronic obstructive pulmonary disease (COPD) makes a major contribution to the total number of deaths particularly in Asaro where it was responsible for more than 15% of all adult deaths (**Figure 7-2**). Almost 40% of cancers in Asaro are thought to be cervical, while 21% are liver. A total of sixteen maternal deaths between the ages of 25-34, which make up 50%, were identified at all four sites but the majority of these deaths took place in Asaro (11 out of 16) (data not shown). All forms of tuberculosis have increased dramatically, especially pulmonary TB. External causes of death play

[18] Neonatal deaths include stillbirths

a significant role in mortality trends in both Asaro and Hides. Almost 60% of all external deaths in Asaro are attributed to homicide, while homicide and road traffic accidents make up 70% of all external deaths in Hides (Figure 7-3).

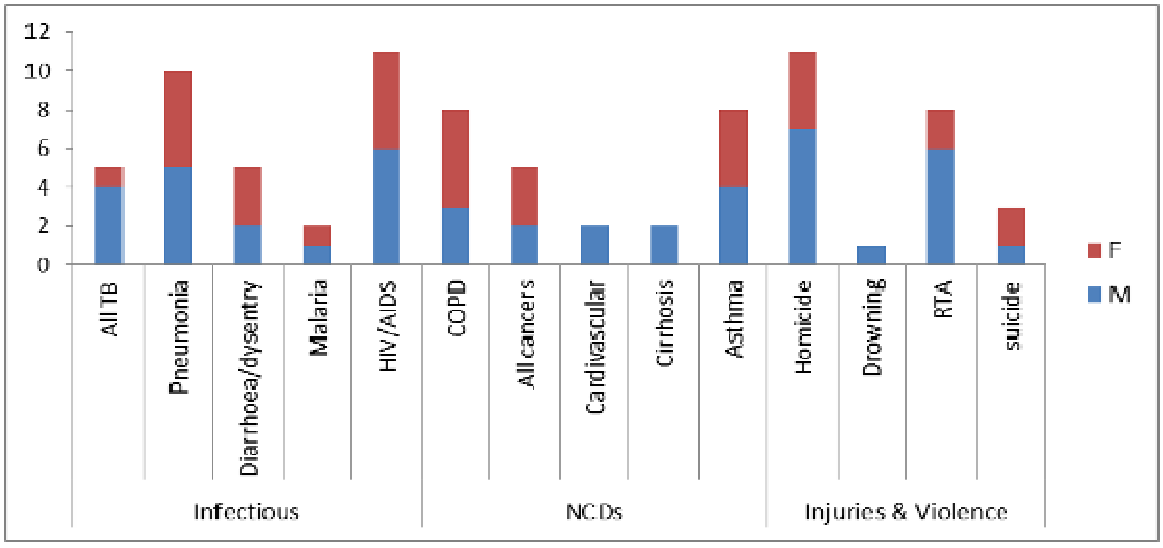


COPD: Chronic obstructive pulmonary disease
HIV/AIDS: Human Immunodeficiency Virus/ Acquired Immunodeficiency Disorder Syndrome
NCD: Non-communicable diseases
RTA: Road traffic accidents

Figure 7-2 Leading causes of adult death in Asaro iHDSS, 2014

7.5.2 Hides

Figure 7-3 shows the leading cause of death among adults in Hides. HIV/AIDS, Homicide and Pneumonia are the leading causes of death. Non-communicable respiratory conditions, i.e. asthma and chronic obstructive pulmonary disease (COPD), make up 13% of adult deaths. Additionally, homicide is also a major contributor to the death toll (15.4%) amongst adults in this area.

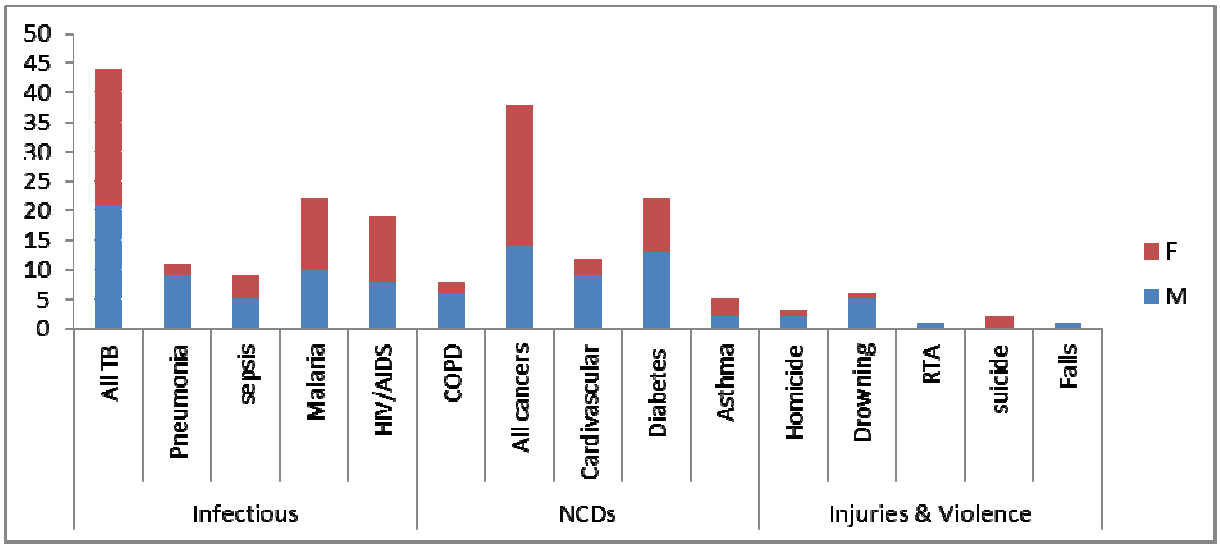


COPD: Chronic obstructive pulmonary disease
HIV/AIDS: Human Immunodeficiency Virus/ Acquired Immunodeficiency Disorder Syndrome
NCD: Non-communicable diseases
RTA: Road traffic accidents

Figure 7-3 Leading causes of adult death in Hides iHDSS

7.5.3 Hiri

Hiri provides a uniquely distinct mortality pattern compared to the other three sites. Unlike the other iHDSS populations, diabetes features in the top five causes of death and is the leading cause of NCD deaths in Hiri (**Figure 7-4**). TB is the leading cause of adult infectious disease deaths in the Hiri iHDSS (11.3%), followed by malaria (6.4%) and HIV/AIDS (6%).

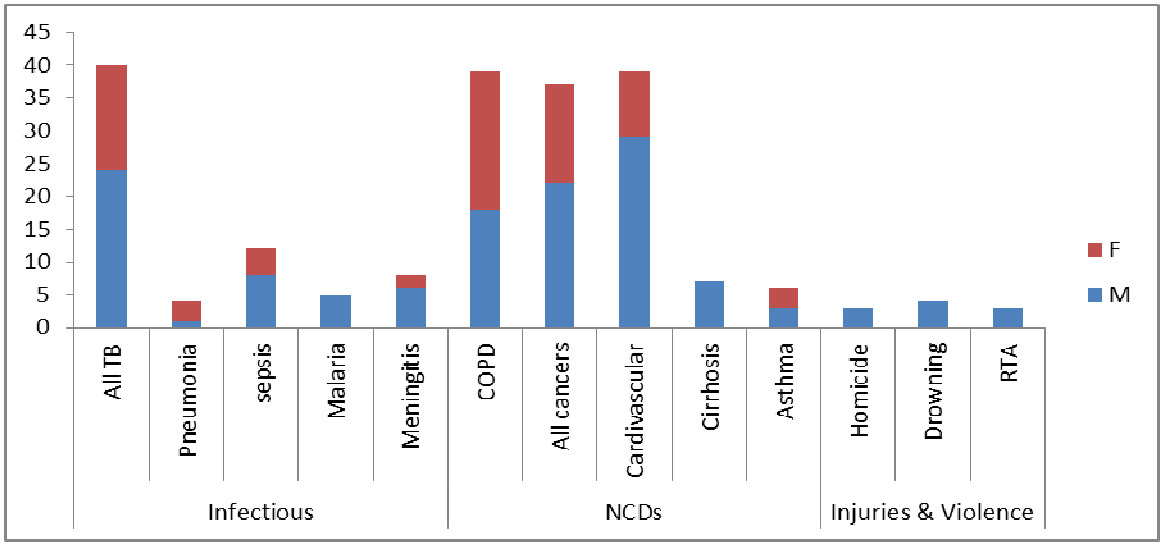


COPD: Chronic obstructive pulmonary disease
HIV/AIDS: Human Immunodeficiency Virus/ Acquired Immunodeficiency Disorder Syndrome
NCD: Non-communicable diseases
RTA: Road traffic accidents

Figure 7-4 Leading causes of adult death in Hiri iHDSS, 2014

7.5.4 Karkar

Figure 7-5 presents the leading causes of adult deaths in Karkar iHDSS. High levels of NCDs are evident in this population, but like in Asaro and Hides, this is largely dominated by COPD including cardiovascular diseases. Deaths caused by cancers are also highly prevalent, predominantly amongst males. Most of these cancers originate from the liver and mouth. External events represent a small fraction of deaths.



COPD: Chronic obstructive pulmonary disease
NCD: Non-communicable diseases
RTA: Road traffic accidents

Figure 7-5 Leading causes of adult death in Karkar iHDSS

7.6 CHILD LEADING CAUSES OF DEATH

Figure 7-6 shows the leading causes of deaths among children by study site. The data indicated that diarrhea/dysentery and pneumonia remain the major killers for children under the age of 15 across all sites, excluding Hiri. In Hiri pneumonia, tuberculosis and AIDS are the leading causes of deaths for children.

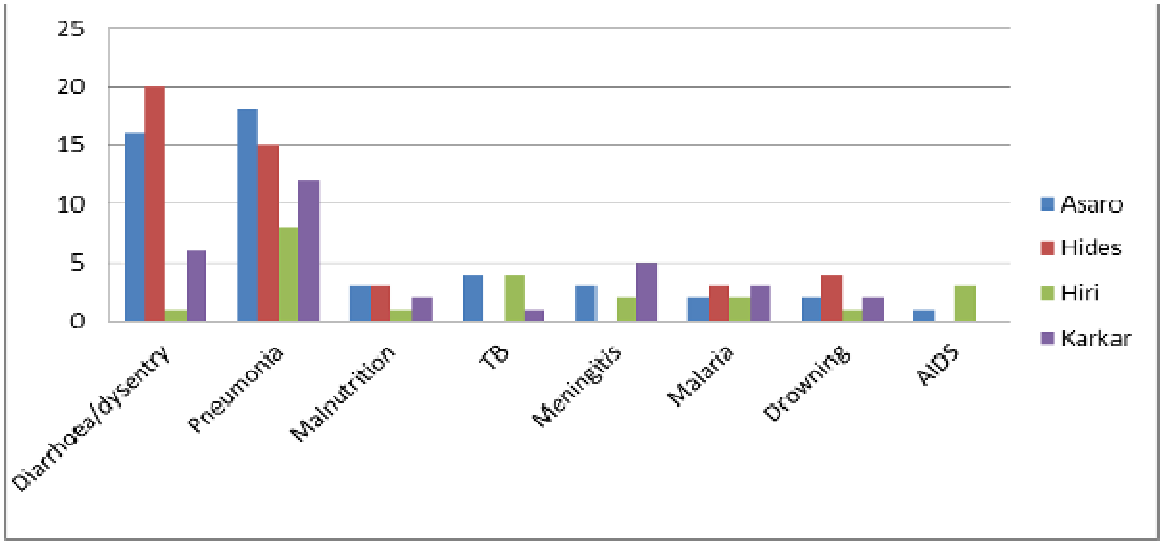


Figure 7-6 Leading causes of child deaths by site, iHDSS, 2015

Table 7-4shows the leading causes of death by age groups. More than 50% of the causes of deaths in age groups 15-34 were attributable to infectious diseases. In contrast, NCDs accounted for approximately 47.7% or more of cause of deaths among population in age groups of 35+. Approximately 18% of deaths among adults were also due to external causes such as injury and violence among adults aged 35-44.

Table 7-4Causes of deaths across iHDSS sites by age group, iHDSS 2015

	Infectious		NCDs		Injuries		Neonatal		Maternal		Indeterminate		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
<1	57	9.5	5	1	6	5.8	112	98.2	3	18.8	4	3.2	187	13
1-4	57	9.5	6	1.2	7	6.8	0	0	0	0	4	3.2	74	5.1
5-14	36	6	4	0.8	9	8.7	1	0.9	0	0	4	3.2	54	3.8
15-24	48	8	13	2.7	11	10.7	0	0	4	25	8	6.4	84	5.8
25-34	80	13.4	34	7.1	18	17.5	0	0	8	50	15	12	155	11
35-44	63	10.6	60	12.4	29	28.2	0	0	1	6.2	8	6.4	161	11
45-54	50	8.4	71	14.7	3	2.9	0	0	0	0	16	12.8	140	9.7
55-64	80	13.4	108	22.3	14	13.6	1	0.9	0	0	12	9.6	215	15
65+	126	21.2	183	37.8	6	5.8	0	0	0	0	54	43.2	369	26
Total	**597**	**100**	**484**	**100**	**103**	**100**	**114**	**100**	**16**	**100**	**125**	**100**	**1439**	**100**

8.0 VERIFICATION AND DISCUSSION

Previous chapters of the report have presented major findings and observations from the population data, extracted from the iHDSS for the reporting period July-December 2014. The data available for Jan-March 2015 have also been included in the report to provide most updated data of the system. The findings were presented for all iHDSS sites and also for each iHDSS site for comparison purposes. When practical, longitudinal findings were presented. In addition impact sites, Hiri and Hides, were compared against Karkar and Asaro respectively.

This chapter discusses three issues: (i) the quality of iHDSS data; (ii) major demographic trends such as fertility and migration in different iHDSS sites; (iii) illness patterns and leading causes of deaths in children and adult populations in different iHDSS sites.

8.1 IMPROVEMENT OF THE QUALITY OF iHDSS DATA

Significant efforts have been made since the last report to enhance and ensure data quality and integrity: (i) coverage of geographical areas and study population; (ii) completeness of population data; and (iii) internal consistency within population data and variables.

The improvement of the iHDSS data quality has been shown by the increase of geographical coverage as reflected in the GPS data of the four iHDSS sites, as shown in **Table 8-1**.

At the village level, GPS data of Hiri iHDSS household distribution is shown in Figures 8-1 through 8-4.

Table 8-1 shows that 319 dwellings in Boera, 468 in Lealea, 228 in Papa, and 676 in Porebada, totaling up to 1,691 dwellings were included in this reporting period.

Table 8-1 Hiri GPS database, Number of Households, iHDSS, 2015

Reporting period	Boera	Lealea	Papa	Porebada	Total
Jul-Dec 2013	24	296	164	446	930
Jan-June 2014	332	383	171	679	1565
Jul-Dec 2014	319	468	228	676	1691

Figures 8-1, 8-2, 8-3 and 8-4 shows GPS Hiri Household Distribution as below.

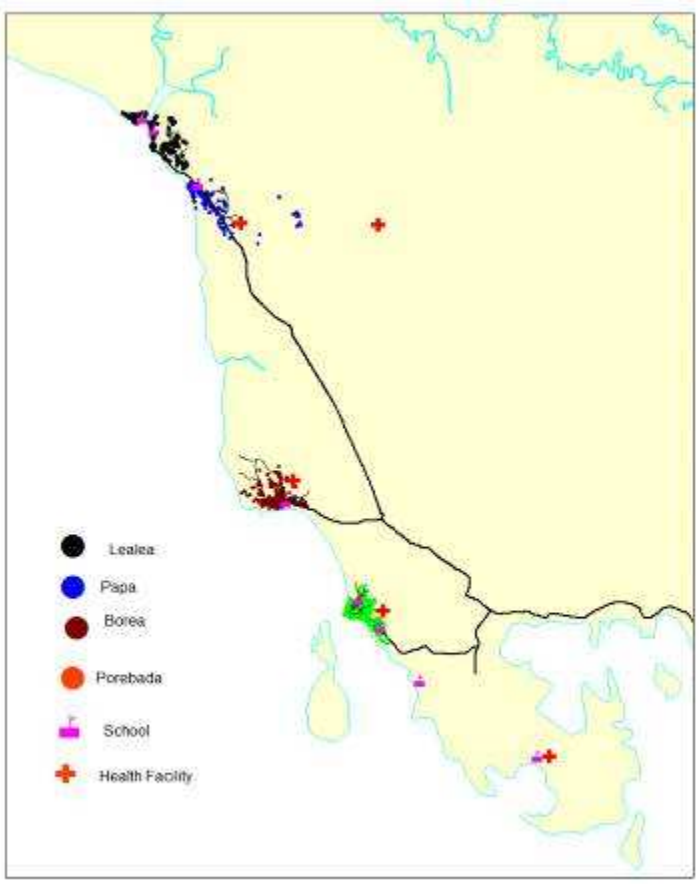


Figure 8-1 Overall Household Distribution per GPS, Hiri iHDSS, 2015

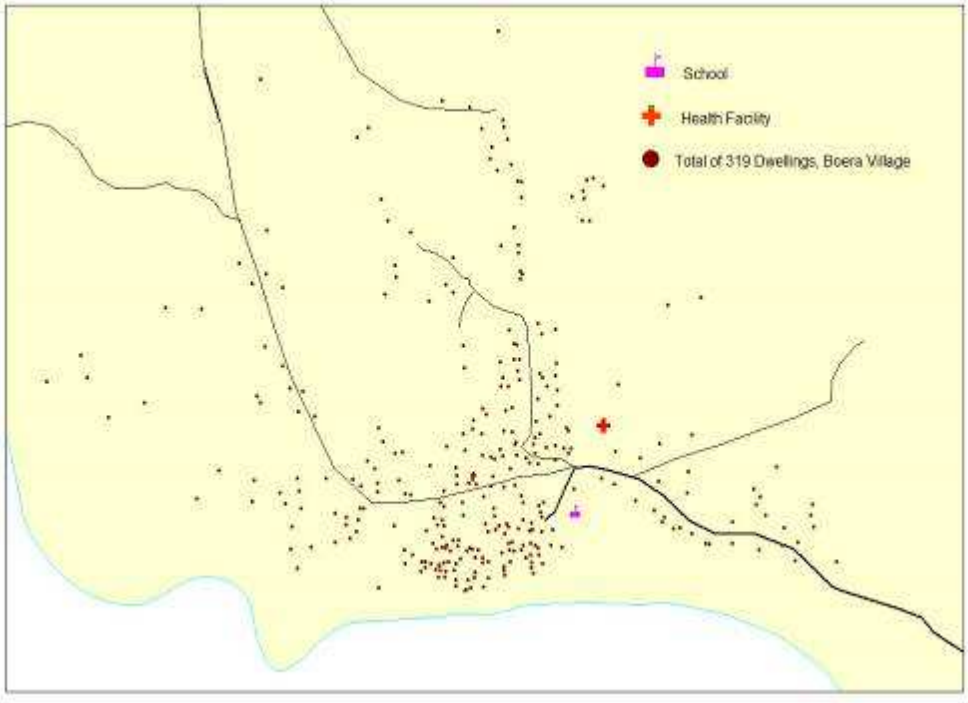


Figure 8-2 Boera Household Distribution per GPS

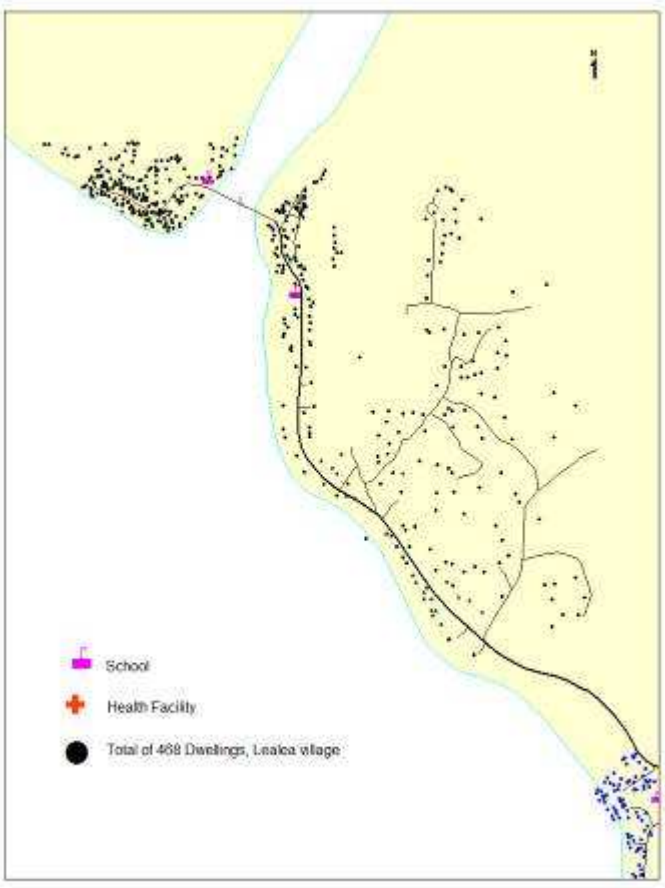


Figure 8-3 Lealea Household Distribution per GPS

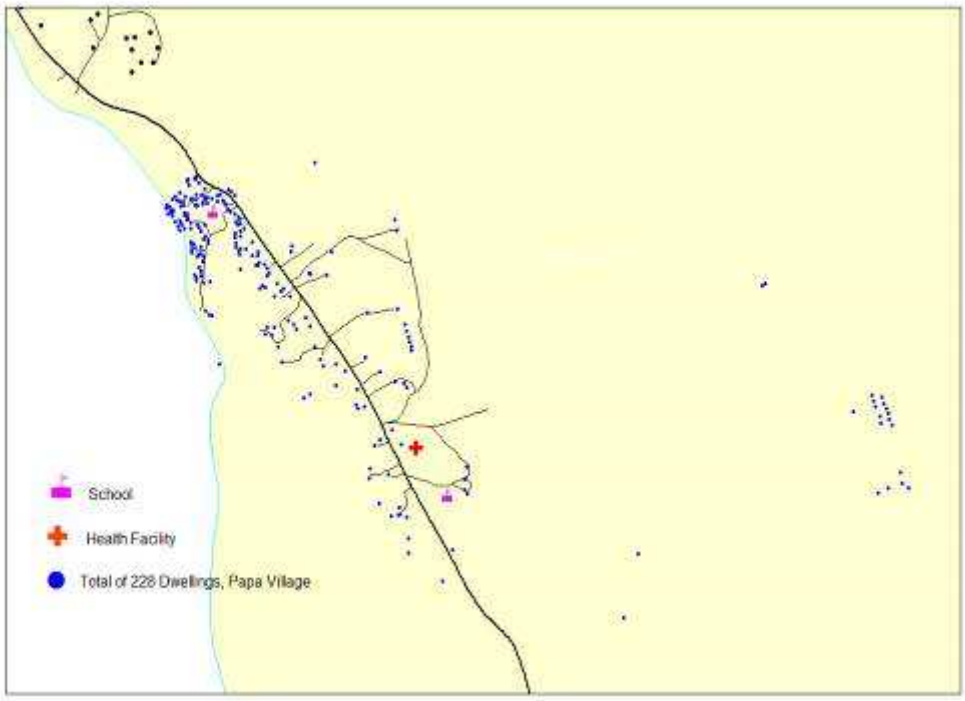


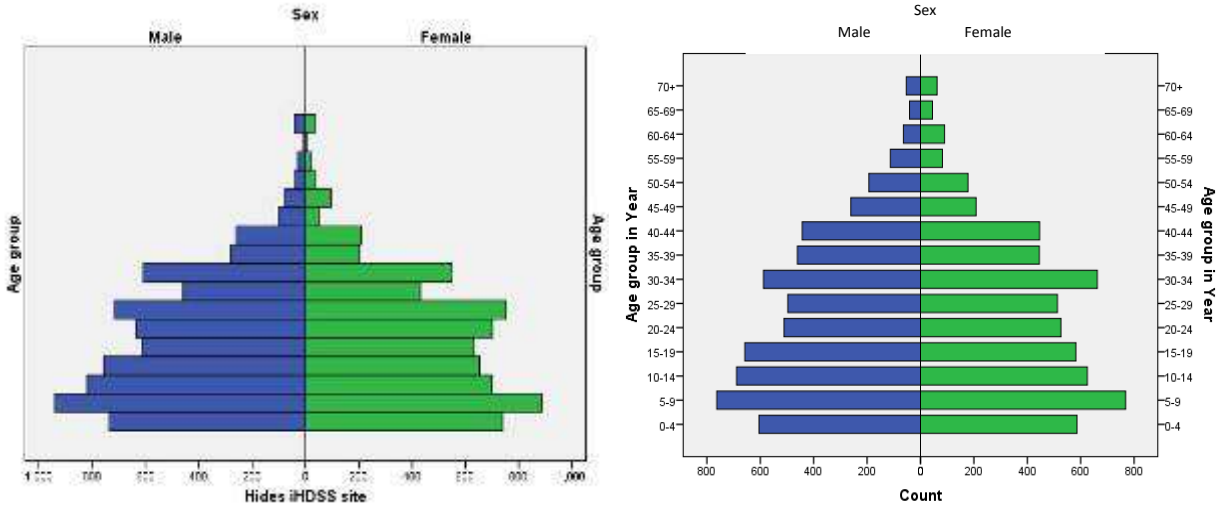
Figure 8-4 Papa Household Distribution per GPS, Hiri IHDSS, 2015

The improvement of iHDSS data quality has been also reflected in the increased numbers of households included in the iHDSS population database. **Table 8-2** shows that the number of households covered by the Hiri iHDSS has increased by 204, from 1390 captured in the Jan-Jun 2014 reporting period to 1594 recorded in this reporting period.

Table 8-2 Number of households recorded in the Hiri population database, iHDSS, 2015

Reporting period	Boera	Lealea	Papa	Porebada	Total
Jan-June 2014	264	359	169	598	1390
Jul-Dec 2014	297	446	203	648	1594

Improvement of iHDSS data quality is also shown in the increased consistency between different population variables. For example, Hides has been always a concern due to many challenges faced by the iHDSS team during the data collection process, from logistics to technical problems.



Population Pyramid of Hides, September 2014 Population Pyramid of Hides, March 2015

Figure 8-5 Comparison of Population Pyramid of Hides in Dec 2014 and March 2015, iHDSS

Figure 8-5 compares the two population pyramids of Hides, drawn out from the Sept 2014 Report and this March 2015 Report. The population pyramid, which was built on the basis of two important variables: 'age' and 'sex' of the population, reflects the internal consistency between the two variables. Visual comparison of the two graphs suggests that the quality of population data of Hides has been considerably improved over the last reporting periods. The current population pyramid looks much more 'normally distribution' as reflected in the general balance between the two sexes and age groups. The significantly longer bar of the population aged 30-34 in both sexes could be explained as bias due to a higher age-specific migration flow of this population into the iHDSS site for economic purposes. This phenomenon has been discussed in previous reports. However, as previously discussed in the migration chapter (Chapter 4), 'Marriage/family' dominates the stated reasons why individuals are in and out migrating.

There has been significant level of completeness for the population data, with key population variables having 95% of completeness. This improvement is the result from a series of new QC/QA measures, which have been applied across all iHDSS locations.

8.2 Declining Fertility

The iHDSS data have highlighted some key population changes in the study sites over the reporting period. The overall population data have shown that the study population are very young. The 0-4 age group population group accounted for 10.4% in Hiri, 6.7% in Karkar, 10.1% in Hides and 7.9% in Asaro, rates that are lower than those reported in the last report. However, the data indicates that a birth boom likely occurred in the 2013/4-time period in Hiri and possibly Hides. The low fertility rate of Asaro could also have been factored by out-migration flow particularly among young women moving out of this site for 'Marriage/ family' purposes.

Given the limited scope of birth data, the total fertility rate (TFR) was not calculated. Further study of fertility of the population is required to provide further insights into this observation and better understand local differentials.

8.3 Migration trends

The development of LNG activities in PNG has been considered as a driver boosting the socio-economic development of PNG, particularly in the two iHDSS sites: Hides and Hiri, where the 22.7 and 17.7 % of the population of working age reported having ever been employed by the LNG. Job and employment opportunities clearly acted as an economic driver, pulling a large number of young males and female workers migrating in Hides and Hiri. The social impact of such economic activities also reflected in the structure of the labour force in Hides and Hiri as discussed in previous report.

The2014 demobilization of the work force could be a driver of out-migration flow from Hiri and hides, i.e., the negative Crude Net Migration Rates. The majority of out-migrants from these sites were of working age, (15-65), and some respondents reported 'Job/employment' and 'Return home' as the reasons for them to leave the places after the duration of stay for 1 or 2 years. However, 'Marriage/family' is still the dominant driver of migration based on overall survey data.

While out-migration from Hiri site has been captured by the iHDSS over the period January 2014-June 2014 and reported in the September 2014 Report, it is likely that this out-migration flow has just started in Hides as reflected the Crude Net Migration Rate at -0.05%. Hides iHDSS site has never experienced out-migration before, with Division 3 experiencing significant population gains due to in-migration. Migration data of Hides showed a high volume, as reflected in a high Crude Gross Migration Rate at 2.35%, including 1.15% of in-migration and 1.2% of out-migration. Future analysis will need to be performed in order to confirm migration trends in both Hiri and Hides.

8.4 Changes in pattern of diseases

PNG is entering a phase of rapid economic development and one that is likely to be characterised by major shifts in traditional social structures and therefore in lifestyles of the population. Population-based studies like the iHDSS have the potential to provide longitudinal and reliable data that can supplement and enhance the understanding of this transition and inform the heath policy decision-makings that should be considered.

The morbidity data presented in this report have a number of limitations. Firstly, the clinic tallies do not provide an individual identifier; therefore, it is impossible to clearly identify new cases or repeated visits to the health clinics. Secondly, there are no quality of the service metrics recorded by any PNG clinics. The Hiri population is quite close to Port Moresby and may choose to attend clinics and hospitals in the city. Mortality data indicate that many people in Hiri die at Port Moresby General Hospital. Similarly, the presence and distance to Goroka Provincial Hospital may also motivate Asaro residents to bypass Asaro Health Centres and Sub-Health Centres for what may be perceived as better or more appropriate services. The results presented in this report should be interpreted with caution because the limitations of the data, not only in terms of sample size, but also the process to recording and reporting the morbidity data at health clinics, particularly in Hides due to social unrest. Failure of follow-ups cases to verify the diagnosis could be another challenge to the improvement of morbidity data. Results will be cross-checked with population surveys conducted within iHDSS populations.

The iHDSS has outlined the overall picture of the burdens of diseases in four iHDSS sites in Asaro, Hides, Hiri and Karkar. The analysis of morbidity data has provided some changes in the patterns of diseases over the last few years, particularly at the impact sites. Nevertheless, preliminary results indicate that respiratory disease cases still dominant the local burden of disease, followed by skin infection diseases and diarrhea.
Though TB and COPD are reported as the leading causes of death in Karkar, these patients are less likely to visit health clinics at the site as reflected in low records of the morbidity data. As showed in the previous PiHP reports, TB data are minimal at local health clinics in Karkar. The underutilization and/or a lack of proper expertise and/or appropriate laboratory equipment could be the reasons underlying ineffective TB interventions at the clinic level.

Further analysis of health seeking behaviour and health service utilisation at the household level are needed to shed light on morbidity data.

8.5 LEADING CAUSES OF DEATHS

The population study was very young as shown in the overall population pyramid for all four iHDSS site as well as the population pyramid of each iHDSS site. Not surprisingly, the death rates of the study population were relatively low as reflected in the Crude Death Rates. For the first time, child mortality data were collected and reported in this report. The information on death certificate was also for the first time reported.

Progress on the Mortality study has been slow but steady. Limited access to iHDSS sites, particularly Hides due to the internal instability could affect the safety and security of field staff and has substantially affected to the fieldwork in the last six months. Nevertheless, all other sites have kept up with the deaths identified through the iHDSS. Mortality surveillance in Hides is incomplete and requires review before conclusions can be made about local trends and patterns.

As discussed previously, there remain a number of limitations to this analysis. Firstly, deaths in this analysis have been presented as proportions of total deaths and not as yearly rates. The calculation of rates will soon possible when a full year of data collection has been complete and physician review on these deaths has been conducted. Therefore, interpretation of results should be done

with a degree of caution. Secondly, no standard approach to physician review has been agreed upon. In order to ensure the highest accuracy in ascribing a probable cause of death to a VA physician review, some researchers recommend that two physicians conduct reviews independently. Where disagreements arise, a third physician is consulted and a consensus must be achieved. At present, there is only one trained physicians dedicated to the task of reviewing VA forms for the PiHP. In addition, forms have to be transported for review further making double review a challenging exercise. Physician review diagnoses may change over time as results are reviewed and physicians continue to receive on-going training in assigning causes of death to verbal autopsies. Verbal autopsies thus far collected can be analysed by computer-based analytical software and results will be compared with the physician review results.

Lastly, this analysis only examines one probable underlying cause of each identified death. A number of conditions, like HIV/AIDS and TB and diabetes and TB, are often associated with one another and many deaths are likely to be due to multiple causes of death. Future analyse should consider potential methods for in-depth investigations into this subject.

High rates of deaths due to NCDs in Hiri and HIV/AIDS, as well as violence, in Hides warrant further investigation and should trigger attention by national and provincial public health authorities. The development of targeted interventions and prevention programs should be also considered by relevant government health officials.

9.0 CONCLUSION

The PiHP underwent significant transformation over the last reporting period including a restructuring of the staff, new design of data collection tools, and the application of a new series of QA/QC measures. The population census update has been successfully conducted in the four iHDSS sites during the reporting period by using the new HH Update Book, Morbidity data collection form. Refresh and follow up trainings have been conducted for data analysis team, data collection team, and data management team, plus a fieldwork for planning and monitoring in the Hiri iHDSS site.

For the reporting period July-Dec 2014, iHDSS recorded a total of 54,339 population records, 11,251 dwellings, 755 births, 121 deaths, 278 in-migrants and 469 out-migrants.

New QA/QC procedures were applied to this data collection and data processing. The new QA/QC procedures also required data entries in the main PNG IMR office in Goroka. QA/QC measures applied in data collection, data entry, and data processing processes are new to most of the PiHP staff; further training and instruction are needed to reinforce the staff compliance. The implementation of QA/QC measures needs to be closely monitored for effective implementation across all iHDSS sites. This approach has allowed an improvement in the operation of the iHDSS in PNG, from data collection, to data entry, data processing and data generation. As part of strengthening of the QA/QC measures in data collection, a fieldwork monitoring and verification exercise was completed at the Hiri iHDSS site in November 2014. The fieldwork has provided further insights into the data collection, recording and reporting processes. GPS data were included in the HH data form for the first time and GPS data were entered as an integral part of the iHDSS database.

As a result, the data quality of the iHDSS has been improved as reflected in the increased geographical coverage, population records with the data completeness of 95% for key population variables. More households and individuals were recorded in the iHDSS as reflected in the increase in number of households included in the iHDSS as well as the number of household members interviewed in this reporting period.

The restructure of the iHDSS and the application of new QA/QA measures will be continuously reinforced across all four iHDSS sites. Although lessons learnt from the fieldwork in Hiri can be replicated in other iHDSS sites, more technical monitoring are needed in Asaro, Hides and Karkar in order to ensure that QA/QC measures are appropriately applied to the entire iHDSS. The iHDSS is designed to produce timely and reliable health and demographic data for policy development that will benefit all citizens of PNG.

10.0 NCD CHAPTER

This report presents findings from a general population prevalence survey of non- communicable diseases (NCDs) and associated risk factors in three integrated Health and Demographic Surveillance Sites (iHDSS) in Hiri (Central Province), Asaro Valley (Eastern Highlands Province) and Karkar Island (Madang). The broad aims of the survey were to: 1) establish baseline prevalence of selected NCDs, associated lifestyle risk factors, dietary habits and food security; and 2) establish a surveillance system for longitudinal monitoring of NCD prevalence and risk.

A total of 774 adults aged between 15-65 years were recruited across the three sites, using simple random selection from a full population census of the adult general population of each iHDSS site. The sample was stratified by age (15-29, 30-44, 45-65 years) and sex. A range of questionnaire, anthropometric and biological data was collected from each participant.

Key findings included:

- 67.4% of participants met criteria for 'substantially increased risk of metabolic complications' based on waist-to-hip ratio
- 63.5% of participants had micro albuminuria
- 49.9% of participants recorded an 'abnormal' lung function
- 43.5% of participants were anaemic
- 43.0% of participants reported 'daily' tobacco use
- 38.9% of participants reported perceived food shortages within the past 12 months.
- 18.7% of participants recorded high blood glucose levels
- 17.7% of participants recorded elevated cholesterol levels
- 15.9% of participants met criteria for hypertension

Site-specific data for these and other variables are detailed in the following pages.

The reported findings indicate an immediate need for NCD prevention, screening and intervention programs within Hiri iHDSS and NCD prevention and health promotion programs across all iHDSS sites. The data from Asaro and Karkar iHDSS are most likely to be representative of NCD burden (and NCD risk) in rural communities across PNG, underlying their value as longitudinal surveillance sites.

10.1 INTRODUCTION

Papua New Guinea (PNG) is a culturally, environmentally and biologically diverse country of approximately seven million people located in the Western Pacific Region. Whilst a low income country according to world bank criteria, PNG is currently experiencing rapid economic development. This development 'boom' is largely driven by a range of mineral and gas resource projects, the most substantial of which is the Exxon Mobil led PNG Liquefied Natural Gas (PNG LNG) project. The PNG LNG project is expected to more than double the PNG gross domestic product and provide a stable revenue stream for 25-30 years once fully operational [1]. As has been observed elsewhere, rapid economic development of this scale is likely to result in an epidemiological transition that sees a reduction in infectious disease and a simultaneous increase in non-communicable diseases (NCDs) as a result of associated lifestyle change [2, 3].

Non-communicable diseases (NCD) are a leading cause of morbidity and mortality throughout the world. In 2005, an estimated 35 million deaths were caused by NCDs (principally, cardiovascular diseases (CVDs), diabetes, cancers, and chronic respiratory diseases), a number predicted to rise by 17% by 2015 [4]. Chronic diseases are further responsible for about 47% of the 1.49 billion years of healthy life "lost" to illness globally [5]. The burden is highest in low income countries where 80% of NCD related deaths occur [4]. Furthermore, about 29% of all NCD related deaths occur in those aged less than 60 years (i.e. an economically active age group) in low-middle income countries compared to 13% in high income countries [6]. The NCD burden is already substantial and growing in the Western Pacific Region (WPR). The WHO estimates that more than 30 million people across WPR countries currently have diabetes mellitus alone and this figure is expected to double by the year 2025 [7].

NCDs and associated risk factors such as smoking, excessive alcohol consumption, obesity, hypertension, abnormal cholesterol and lipid profiles, and physical inactivity have not been well investigated in PNG. A number of relatively small studies conducted among specific populations have identified an increasing or relatively high prevalence of diabetes, cardiovascular disease and cancers [8-14]. Available evidence further suggests variation in NCD risk within PNG based on ethnic origin [15-17] and lifestyle and living environment [18. 19]. For example, the Wanigela people of Port Moresby have some of the highest rates of diabetes recorded in the Pacific [9] and urban dwellers of any ethnic origin in PNG are more at risk of NCDs relative to their rural peers [11, 18], although even rural populations appear to be increasingly prone to NCDs [12]. NCDs currently account for a minor proportion of outpatient and inpatient admissions within the country [20], yet this is not necessarily reflective of treatment need. According to a survey completed in 2000, less than half of the estimated 180,000 diabetes cases in PNG were on treatment [8], suggesting a majority of diabetic cases go undiagnosed or untreated. Given the acknowledged shortcomings of the PNG health system, including deteriorating infrastructure, poor governance, aging and inadequate healthcare workforce and a paucity of specialist services [21-24], then it is likely that many (if not most) other forms of NCD are equally undetected or untreated.

Despite the aforementioned studies, the PNG evidence-base is currently insufficient to reliably identify the prevalence of NCDs across the country. Neither is there the capacity within the current health system to monitor the anticipated epidemiological transition and the expected rise in NCD prevalence and associated risk factors. As such, it is prudent to establish prevalence for NCDs and their risk factors in the early stages of the development 'boom' as well as implement a reliable monitoring system. By doing so, subsequent changes in NCD burden and their associated risk factors may be readily identified and appropriate public health interventions and policies developed and deployed in a timely manner. Accordingly, the aims of this study were to:

1. Establish a baseline data set to determine among people living in three diverse study sites:

    a. the prevalence of selected NCDs (namely diabetes mellitus type 2, hypertension, acute coronary syndrome, stroke, chronic lung diseases and cancers) and associated lifestyle risk factors;
    b. dietary habits and food security; and

2. Establish a surveillance system for longitudinal monitoring to detect any changes in the prevalence of NCDs and associated lifestyle risk factors, and also any changes in dietary habits and food security, among the three study sites.

10.2 METHODOLOGY

Study Design

The study is a cross sectional survey conducted in three integrated Health and Demographic Surveillance Sites (iHDSS) established as part of a larger research program [25]. Detailed demographic records are maintained and regularly updated for each site and a wide range of socio-demographic and health data are continuously collected at an individual and household level. The study included completion of a standardised questionnaire loosely based on the WHO STEPS NCD Risk Factor survey, a 24 hour dietary recall (not reported herein), selected physical measurements and biological sample collection with randomly selected adults (15-65 years) from the general population of each iHDSS. Pending continued funding, repeat cross sectional surveys will be completed in each iHDSS to allow longitudinal surveillance of NCD risk factors and prevalence.

Sample Size and Selection

A total of 300 adult participants stratified according to sex and age (15-29, 30-44, 45-65 years) were sought from each iHDSS (i.e. 100 participants from each of the three age groups, 50 male and 50 female, were sought from each site). Study participants were selected from each iHDSS using a simple random sampling procedure. The sampling frame was a full population census of the adult general population of each iHDSS stratified by age and sex. The overall sample size (n=900) was calculated to confer 80% power and a 0.05 significance level (2-sided).

The three iHDSS include the West Hiri iHDSS (Central Province) located in a PNG LNG project impact site and the Asaro Valley iHDSS (Eastern Highlands Province) and Karkar Island iHDSS (Madang Province) located in non-project comparison sites. The West Hiri iHDSS comprises the villages Porebada, Boera, Papa, and Lealea in Hiri District with the baseline (2011) population recorded at 11,531 people [24]. The West Hiri villages are distributed along a 20-30 kilometre stretch of coastline starting about 20 kilometres North West of Port Moresby, the National Capital and largest city in PNG. The villages have been affected by their proximity to Port Moresby and traditional skills in fishing, gardening and other areas have been eroded [26]. Subsistence farming is relatively rare within the Hiri iHDSS, with the majority of the adult population (15-64 years) engaged in some form of employment, including on the LNG-PNG project [25]. The West Hiri iHDSS surrounds the PNG LNG processing site.

The Asaro Valley iHDSS comprises a baseline (2011) population of 10,034 people [25] situated within 40 kilometres of Goroka Town. Rural people in the Asaro Valley live in hamlets, grouped together into villages and most houses are made out of bush material. People are primarily subsistence farmers, but earn cash through smallholder production of coffee, employment on plantations and marketing of garden produce [27]. The Karkar Island iHDSS comprises an approximate population of 20,000 people [25] and is located about 30 kilometres off the Northern coastline of Madang Province. The island's soil is known for its fertility and large plantations produce the island's main exports of cocoa and coconut and provide a large amount of the local employment opportunities. Subsistence farming and unskilled labour are the primary occupations of the adult (15-64 years) population and most houses are made out of bush material or are semi-permanent [25].

Procedures

Interviews were conducted at participants' homes, or community-based health facilities. The study purpose and procedures were explained to participants and written consent obtained prior to participating in the study. To be eligible to take part in this survey, an individual had to meet the following criteria: living in one of the three iHDSS; aged between 15-64 years; and consented to be part of the study. Individuals were excluded from the study if they were pregnant or were known or reported to have a mental illness. All survey forms and procedures were completed at a single time point; however, participants were provided a specimen container the evening prior to survey for an early morning urine collection or the urine specimen was collected the day after survey. Non-clinical components of the adult NCD questionnaire, 24 hour dietary recall and all physical measurements were completed by a trained research officer. Clinical components of the NCD questionnaire and all biological samples were collected by a qualified health professional.

Each adult participant's blood sample was analysed and investigated for anemia, Haemoglobin A1c (as a marker for diabetes mellitus) and associated NCD risk factors such as elevated cholesterol or triglycerides. NCDs were determined based on clinical findings during the NCD survey in the field and/or from laboratory results. Participants identified to have NCDs during the field survey were referred to the local General Hospital for further investigation and management without delay. Participants with laboratory confirmed NCDs were scheduled to be seen by a visiting medical registrar in the health facility closest to the respective iHDSS. All data were collected between April 2013 and October 2014. This study was approved and granted ethical clearance by the PNGIMR Institutional Review Board (IRB) and the PNG Medical Research Advisory Committee (MRAC) (IRB No. 1208, 23 March, 2012; MRAC No.12.34, 19 November, 2012).

Measures

NCD Risk Factor Questionnaire: An interviewer administered questionnaire based on the WHO STEPS NCD Risk Factor survey. Question domains included: participant demographics, self-reported health status, self-reported stress or anxiety, diet, food security, tobacco, buai and alcohol use, physical activity and participant history of NCD and/or associated treatments. The self-reported stress/anxiety, diet and physical activity questions were all developed specifically for this study and for use with PNG-based populations. The questionnaire was available in English and *Tok-Pisin* versions. The *Tok-Pisin* version was translated from the English original and back-translated for accuracy. All questionnaires were piloted extensively prior to survey commencement.

24 Hour Dietary Recall (not reported herein): A structured interview designed to collect quantitative information on all foods and drinks consumed by the participant the day prior to survey (from midnight to midnight), including foods and drinks consumed both at and away from home. The 24-hour dietary recall was administered in the following four stages using a standardised protocol [28]: 1) A 'quick list' of all foods, beverages and dietary supplements consumed during the preceding day was obtained; 2) Detailed descriptions were then sought of all items consumed, using specific questions and prompts, including cooking method, recipe for mixed dishes (where known), any additions made before consumption, where the food was sourced, brand and product name and time consumed. 3) Estimates were then made of amounts of items consumed, wherever possible (e.g. cups, tablespoons), using food photographs, shape dimensions, food portion assessment aids (e.g. dried beans) and packaging information; and 4) All items were reviewed in chronological order. Any additions and changes were

made at this point. On completion of the 24-hour diet recall, the interviewer asked the participant to show them any container in which salt used by the household was purchased. Once it had been sighted the interviewer recorded size of container and frequency of purchase. The questions were adapted from the salt module of the 2005 PNG National Nutrition Survey [29].

Physical Measurement: Weight records were obtained using a *Seca* uniscale with 100g precision. Stature was measured to 0.1 cm precision using a Seca leiscester height measure or stadiometer with plastic tape measure securely taped against a flat timber with participants standing at a plane position against it. A figure finder constant tension tape was used to measure waist and hip circumferences with precision to 0.1 cm. An OMRON T9P digital automatic blood pressure monitor was used to measure blood pressure three times at one minute intervals. All participants were measured in the sitting position after resting for more than 10 minutes. Systolic and diastolic readings from the digital monitor were recorded. Heart rate was measured from the automatic blood pressure monitor. Lung function was measured using a portable spirometer. Measurement included forced vital capacity (FVC) and the forced expiratory volume (FEV1). Each participant was asked to blow three times into the mouth piece of the spirometer before a reading was taken and recorded.

Capillary Blood: Finger prick blood spot analysed for haemoglobin levels using a portable Hemocue device.

Venous Blood: 30mls of non-fasting blood was collected by venepuncture using size 20-21G butterfly needles into 2 types of sample containers. From each participant, the initial 10mls of blood was collected into EDTA vacutainers and another 20mls into serum vacutainers. All samples were separated into several aliquots and stored initially at -20°C until analysed in batches within 1-2 months of collection. EDTA samples were analysed for Haemoglobin A1c. The serum samples were analysed for lipid profile which includes total cholesterol, triglycerides, low and high density lipoprotein. After analysis, remaining aliquots were placed in -80°C freezers for long-term storage.

Urine: An early morning urine sample was collected from each adult participant and analysed for microalbuminuria and cortisol levels; the latter as a general indicator of stress [30, 31].

Complementary data: Information pertaining to education and occupation was available for all survey participants from complementary datasets collected as part of the larger iHDSS research program.

Determining Non-Communicable Disease

In accordance with the American Diabetes Association standards of medical care in diabetes [32], diabetes mellitus type 2 was diagnosed if an adult participant's Haemoglobin A1c ≥ 48 mmol/l (≥6.5%). The above criteria were confirmed by repeat testing on a different day. Hypertension was diagnosed if blood pressure is >140/90 mmHg (seated and after 5 minutes rest). Three separate readings were conducted to confirm hypertension. An elevated lipid profile was defined according to the updated guidelines for cholesterol management and the 2011 report of the National Cholesterol Education Program expert panel team in the evaluation, monitoring and treatment of cholesterol in adults [33, 34]: Normal Cholesterol levels if <200 mg/dL or (5.17 mmol/L), borderline high if 200-239 mg/dL or 5.2 to 6.2 mmol/L and elevated if > 240 mg/dL or >6.21 mmol/L; Poor HDL-cholesterol levels if<40mg/dL or (<1.03 mmol/L) and elevated or best if >60 mg/dL or >1.55 mmol/L, normal triglyceride if <150mg/dL or <1.7mmol/L, borderline high if 150 to 199 mg/dL or 1.7 -2.2 mmol/L, high if >200-499 mg/dL or >2.3 mmol/L, normal LDL-c if <2.6 mmol/L or <100 mg/dL, above optimal if 2.6-3.3 mmol/L or 100-129 mg/dL,

high if >3.3 mmol/L or >130 mg/dL. Microalbuminuria was defined as an albumin/creatinine ratio (ACR) ≥2.5mg/mmol and ≥3.5mg/mmol for males and females, respectively [35]. Obstructive pulmonary disease was diagnosed if lung function FEV1/FVC <0.7. Anaemia was diagnosed if haemoglobin level was below the WHO Hemoglobin thresholds [36]: Women, non-pregnant (>15 years) Hb threshold 12.0 g/dL or 7.4 mmol/L; men (>15 years) Hb threshold 13.0 g/dL or 8.1 mmol/L.

Data Analysis

Stata/SE version 12 was used for all data analysis. Analysis was limited to descriptive summaries of all major measures obtained during the NCD survey and inferential analyses assessing inter-site differences on major outcome variables, using chi-square, one-way ANOVA, t-test, or Kruskal-Wallis as appropriate. More detailed analyses exploring relationships between specified risk factors and NCDs will be presented in subsequent peer-reviewed publications. The totals (No.) presented in all Tables are denominators unless otherwise stated. There is some variance in the totals presented across Tables due to missing data on certain variables. It should also be noted that the tobacco, buai and alcohol questions were not originally included in the NCD questionnaire and, as a result, these questions were not asked of all participants.

10.3 RESULTS

Sample Characteristics

Participant age and sex characteristics are presented in **Table 10-1**. As shown, a majority of participants were in the 45-65 year age category (38.2%) and a minority in the 15-29 year age category (27.9%). The mean participant age was 39.2 years (SD 13.8). No statistically significant differences between iHDSS were identified in the distribution of participants across the three age categories (p=0.986) or in mean age (p=0.708). Some variation in participant sex ratio was evident across sites, although not at a level of statistical significance (p=0.192).

Table 10-1. Participant age and sex characteristics

Site	No.	Age (yrs)			Sex	
		15-29	30-44	45-65	Male	Female
Hiri	268	27.2%	35.1%	37.7%	43.3%	56.7%
Asaro	254	27.2%	34.7%	38.2%	51.2%	48.8%
Karkar	252	29.4%	31.8%	38.9%	46.4%	53.6%
Overall	**774**	**27.9%**	**33.9%**	**38.2%**	**46.9%**	**53.1%**

Participant education levels and occupations are presented in **Tables 2 and 3**, respectively. Overall, 67.1% of participants had received less than a secondary level education (≤ primary) and only 3.4% a tertiary or vocational education. Participant education levels were higher in Hiri relative to other iHDSS and at a statistically significant level (p<0.001). The majority of participants were subsistence farmers or cash croppers (45.1%) or responsible for home duties (20.3%). Statistically significant variation in the percentage of participants in each occupation grouping was evident across iHDSS (p<0.001) with a greater proportion of participants in paid employment in Hiri iHDSS and a conversely lower proportion of subsistence farmers/cash croppers relative to other sites.

Table 10-2. Participant education level

Site	No.	Highest education level attained			
		≤ Primary	≤ Secondary	Tertiary/vocat.	Not answered
Hiri	268	44.4%	34.7%	7.5%	13.4%
Asaro	254	78.0%	11.0%	1.2%	9.8%
Karkar	252	80.2%	15.5%	1.2%	3.2%
Overall	**774**	**67.1%**	**20.7%**	**3.4%**	**8.8%**

Table 10-3. Participant occupation

Site	No.	Occupation				
		Paid employment	Subsistence/ cash cropper	Home duties	Student/ unemployed	Not answered
Hiri	268	33.6%	8.6%	34.3%	20.9%	2.6%
Asaro	254	5.9%	70.5%	5.9%	9.5%	8.3%
Karkar	252	6.8%	58.3%	19.8%	13.9%	1.2%
Overall	**774**	**15.8%**	**45.1%**	**20.3%**	**14.9%**	**3.9%**

Self-Reported Health Status

As shown in **Table 4**, a majority of participants' rated their general health 'excellent' (26.3%) or 'good' (32.6%). A statistically significant difference in self-rated general health status was identified across sites ($p<0.001$) with ratings of health status lowest in Asaro where a majority of participants rated their health as 'moderate' (42.5%) or 'bad' (42.9%) and highest in Karkar where a majority of participants rated their health as 'excellent' (69.8%).

Overall, 32% of participants considered their own general health status to be 'better than' others, 53.8% the 'same as' others and 14.3% 'worse than' others (Table 5). Again, statistically significant differences were evident across sites ($p=0.001$) with a majority of participants from Asaro rating their own health the 'same as' (39.4%) or 'worse than' (31.5%) others as compared to participants from Hiri and Karkar who were more likely to rate their own health the 'same as' (63.0% and 60.2%, respectively) or 'better than' (30.5% and 36.7%) others.

Table 10-4. Self-rated general health status

Site	No.	Self-rated health status				
		Excellent	Good	Moderate	Bad	Very Bad
Hiri	259	7.3%	62.6%	23.2%	6.2%	0.8%
Asaro	252	2.4%	10.7%	42.5%	42.9%	1.6%
Karkar	252	69.8%	23.8%	6.0%	0.4%	0%
Overall	**763**	**26.3%**	**32.6%**	**23.9%**	**16.4%**	**0.8%**

Table 10-5. Self-rated general health status as compared to others

Site	No.	Self-rated health status as compared to others		
		Better than	Same as	Worse than
Hiri	243	30.5%	63.0%	6.5%
Asaro	254	29.1%	39.4%	31.5%
Karkar	226	36.7%	60.2%	3.1%
Overall	**723**	**32.0%**	**53.8%**	**14.3%**

Mental Health Status

The NCD questionnaire included up to three questions (the number dependent upon participant response) examining aspects of participant mental health. This included a general question asked of all participants as to whether they were currently experiencing any 'wari or hevi' (stress or concern) and, if the response was 'yes', two further questions exploring potential sleeping difficulties or appetite changes experienced as a result of these concerns. Findings are presented in Table 6. Overall, 32% of participants reported experiencing a current 'wari or hevi'. Participants from Hiri and Asaro iHDSS were significantly more likely to report a current wari/hevi as compared to participants from Karkar (46.2%, 44.1% & 4.8%, respectively; p<0.001). Of those participants who reported a current wari/hevi, 59.5%reported experiencing some sleep loss in the past week as a result and 33.2% reported a change in appetite. Inter-site variation on the latter two measures did not reach levels of statistical significance (p<0.073 & p<0.560, respectively).

Table 10-6. Percentage of participants' reporting a current *wari* or *hevi* and related loss of sleep or appetite change

Site	Experienced wari/hevi		Experienced sleep loss*		Experienced appetite change*	
	No.	% (95% CI)	No.	% (95% CI)	No.	% (95% CI)
Hiri	266	46.2 (40.1, 52.4)	121	63.6 (54.4, 72.2)	122	34.4 (26.1, 43.6)
Asaro	254	44.1 (37.9, 50.4)	110	52.7 (43.0, 62.3)	111	30.6 (22.2, 40.1)
Karkar	252	4.8 (2.5, 8.2)	11	81.8 (48.2, 97.7)	11	45.5 (16.7, 76.6)
Overall	**772**	**32.0 (28.7, 35.4)**	**242**	**59.5 (53.0, 65.7)**	**244**	**33.2 (27.3, 39.5)**

* Only asked if participant responded 'yes' to having a current wari/hevi

Food Consumption

The median number of days on which one or more of the specified food groupings/items were reportedly consumed during a typical week (7 days) over the month prior to survey are presented in Tables 7 and 8. The interquartile range (IQR) is presented in brackets.

Table 10-7 Self-reported frequency with which vegetables, fruits and meat were consumed during a typical week in past month

Site	No.	Median No. (IQR) of days in which listed food items consumed				
		Root veges./banana	Greens/ other veges.	Fruit	Fresh meat	Tinned meat
Hiri	267	2 (2)	1 (3)	1 (4)	4 (5)	5 (5)
Asaro	254	7 (1)	7 (3)	2 (2)	1 (1)	2 (2)
Karkar	252	7 (0)	7 (0)	0 (0)	2 (7)	0 (0)
Overall	**773**	**7 (4)**	**7 (5)**	**1 (2)**	**2 (6)**	**2 (4)**

Variation in the reported frequency of consumption was evident across sites, reaching a level of statistical significance on all items: root vegetables/banana ($p<0.001$); greens/other vegetables ($p<0.001$); fruit ($p<0.001$); fresh meat ($p<0.001$); tinned meat ($p<0.001$).

Table 10-8. Self-reported frequency with which fired foods, sugary drinks and salted food were consumed during a typical week in past month

Site	No.	Median No. (IQR) of days in which listed food items consumed				
		Fried food from shop	Fried food from home	Soft drinks	Stock added to food	Salt added to food
Hiri	267	0 (1)	2 (2)	1 (2)	0 (0)	7 (5)
Asaro	254	1 (1)	3 (5)	1 (1)	0 (1)	7 (5)
Karkar	252	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Overall	**773**	**0 (1)**	**2 (3)**	**0 (1)**	**0 (0)**	**5 (7)**

Variation in the reported frequency of consumption was evident across sites, reaching a level of statistical significance on all items: fried food from shop ($p<0.001$); fried food from home ($p<0.001$); soft drinks ($p<0.001$); maggie stock ($p<0.001$); and salt ($p<0.001$).

Food Security

Overall, 38.9% of participants reported that there were times in the past 12-months where some people in their respective communities ate less than they should have because they did not have sufficient food to eat (Table 9). This varied between a high of 64.3% of participants in Asaro and a low of 6.9% in Karkar. The variation between sites reached a level of statistical significance ($p<0.001$).

Table 10-9. Percentage of participants' reporting perceived food shortages in their respective communities within the past 12 months

Site	No.	Reported food shortage % (95% CI)
Hiri	259	44.8 (38.6, 51.1)
Asaro	252	64.3 (58.0, 70.2)
Karkar	248	6.9 (4.0, 10.7)
Overall	**759**	**38.9 (35.4, 42.4)**

Participants who responded 'yes' to the question exploring perceived food shortages in their respective communities were asked 'how often' such shortages were thought to occur (Table 10). As shown in Table 10, Hiri participants were more likely to report food shortages 'every month' as compared to participants from the other iHDSS. The inter-site variation in the reported frequency of food shortages reached a level of statistical significance (p<0.001).

Table 10-10. Reported frequency with which perceived food shortages were thought to occur within past 12 months*

Site	No.	Reported frequency of perceived food shortages		
		Every month	Some, but not all months	Only one or two months
Hiri	114	20.2%	63.2%	16.7%
Asaro	160	1.3%	55.0%	43.7%
Karkar	16	0%	0%	100%
Total	**290**	**8.6%**	**55.2%**	**36.2%**

* Analysis restricted to 260 participants who reported a perceived food shortage in their respective communities

Tobacco Use

Table 11 presents the percentage of participants' who identified themselves as 'current' or 'daily' smokers. The inter-site variation approached statistical significance for 'current smokers' (p=0.080) and reached significance for 'daily smokers' (p=0.019). For those who identified as current 'daily' smokers, the mean age of starting daily smoking was 18.9 years (SD 6.9) and the mean number of tobacco products smoked per day was 5.5 (SD 4.9). No statistically significant differences in the mean smoking age or the mean number of tobacco products smoker per day were identified by site (p=0.4562 & p=0.9599, respectively).

Table 10-11. Percentage of participants' reporting to be a current or daily smoker

Site	No.	Current smoker % (95% CI)	Daily smoker % (95% CI)
Hiri	173	39.9 (32.5, 47.6)	36.5 (29.2, 44.2)
Asaro	189	46.6 (39.3, 53.9)	41.0 (33.9, 48.3)
Karkar	202	51.5 (44.4, 58.6)	50.5 (43.4, 57.6)
Overall	**564**	**46.3 (42.1, 50.5)**	**43.0 (38.9, 47.3)**

Table 12 presents the percentage with which three specified types of tobacco product were reportedly used by daily smokers. The use of manufactured cigarettes was highest in Hiri iHDSS (58.2%) and nil in Karkar. Conversely, the use of 'brus' (homegrown tobacco) was exclusive to Asaro and Karkar iHDSS where it was the most frequently reported form of tobacco consumption.

Table 10-12. Reported use of three types of tobacco product (daily smokers only)*

Site	**No.**	**Cigarettes % (95% CI)**	**Spear/mutrus % (95% CI)**	**Brus % (95% CI)**
Hiri	60	58.3 (44.9, 70.9)	65.0 (51.6, 76.9)	0 (0, 6.0)
Asaro	75	22.7 (13.8, 33.8)	9.3 (3.8, 18.3)	89.3 (80.1, 95.3)
Karkar	92	0 (0, 3.9)	1.1 (0, 5.9)	95.6 (89.1, 98.8)
Overall	**227**	**22.9 (17.6, 28.9)**	**20.7 (15.6, 26.6)**	**68.1 (61.6, 74.2)**

*Analysis restricted to 227 participants who reported daily tobacco use.

Buai Use

Table 13 presents the percentage of participants who reported buai consumption in the past 30 days. Use was highest in Hiri and lowest in Asaro (93.5% & 55.1%, respectively) with inter-site variation reaching a level of statistical significance ($p<0.001$). Mean number of days in which buai was chewed in the past 30 days and mean number of nuts chewed per day, as reported by participants who had chewed at least one nut in the past 30 days, was 25.7 (SD 8.8) and 6.2 (SD 5.7), respectively. A statistically significant difference in mean number of days in which buai was chewed was identified between sites (29.7±2.1 in Karkar vs.21.1±11.1 and 24.6±9.5 in Asaro and Hiri, respectively; $p<0.001$). No statistically significant variation in reported number of nuts chewed was identified. 92.4% of participants reporting buai use in the past thirty days further reported that they 'always' use mustard and lime when chewing.

Table 10-13. Percentage of participants' reporting buai use in the past 30 days

Site	**No.**	**Use in past 30 days % (95% CI)**
Hiri	155	93.5 (88.5, 96.9)
Asaro	167	55.1 (47.2, 62.8)
Karkar	170	86.5 (80.4, 91.2)
Overall	**492**	**78.0 (74.1, 81.6)**

Alcohol Use

Self-reported consumption of alcohol at any point in time (ever), in the past 12-months and past 30 days is presented in Table 14. Reported alcohol consumption on all three measures was lowest in Karkar iHDSS. The percentage of participants reporting having 'ever' consumed alcohol was similar in Hiri and Asaro (65.8% and 66.3%, respectively), although a higher percentage of participants from Hiri reported alcohol use in the past 12-months or 30- days. The inter-site variation in reported alcohol consumption reached statistical significance on all three measures ('ever' p<0.001; '12-months' p<0.001; '30-days' p<0.001, respectively).

Table 10-14. Percentage of participants' reporting alcohol consumption

Site	No.	Alcohol use measure		
		Ever	Past 12 months	Past 30 days
		% (95% CI)	% (95% CI)	% (95% CI)
Hiri	152	65.8 (57.7, 73.3)	58.3 (50.0, 66.2)	45.1 (36.8, 53.6)
Asaro	169	66.3 (58.6, 73.4)	40.4 (32.9, 48.1)	22.9 (16.7, 30.0)
Karkar	200	42.0 (35.1, 49.2)	19.6 (14.3, 25.8)	7.1 (4.0, 11.7)
Overall	**521**	**56.8 (52.4, 61.1)**	**37.6 (33.4, 41.9)**	**23.1 (19.5, 27.0)**

Physical Activity

Table 15 presents the median hours or minutes per day (and inter quartile range in brackets) spent on sedentary, moderate or vigorous physical activity by sex and iHDSS. As shown, both male and female participants from Karkar reported the highest median number of sedentary minutes per day (397.1 and 425.0, respectively). Male and female participants from Asaro reported the highest median number of moderate activity minutes per day (62.3 and 61.5, respectively) and median minutes spent on vigorous activity were uniformly low across sites (ranging from 0 for females from Karkar to 2.8 for males from Karkar). Inter-site variation reached a level of statistical significance on all measures for both sexes (Male: Total, p=0.006; Sedentary, p=0.027; Moderate, p<0.001; Vigorous, p<0.001; Female: Total, p<0.001; Moderate, p<0.001; Vigorous, p<0.001) with the exception of total hours spent per day on sedentary activity among females (p=0.052).

Table 10-15. Median (IQR) hours (hrs) or minutes (mins) spent per day (d) on sedentary, moderate or vigorous physical activity by sex and iHDSS*

Site	Male					Female				
	No.	Total Hr/d	Sedentary Min/d	Moderate Min/d	Vigorous Min/d	No.	Total Hr/d	Sedentary Min/d	Moderate Min/d	Vigorous Min/d
Hiri	68	13.1 (5.7)	311.5 (307.1)	29.8 (97.1)	0.2 (14.0)	84	11.6 (3.8)	366.0 (155.1)	14.9 (35.3)	0.7 (1.3)
Asaro	91	13.3 (6.2)	336.6 (185.1)	62.3 (83.0)	0.3 (2.7)	84	15.3 (7.6)	370.1 (239.2)	61.5 (58.5)	0.4 (0.9)
Karkar	59	10.8 (5.0)	397.1 (193.1)	20.5 (33.8)	2.8 (1.2)	79	10.1 (3.6)	425.0 (172.1)	22.4 (43.7)	0 (0)
Overall	**218**	**12.5 (5.7)**	**341.3 (239.8)**	**40.3 (78.1)**	**0.2 (3.3)**	**247**	**11.9 (6.0)**	**383.5 (201.0)**	**33.7 (62.6)**	**0.2 (1.0)**

* Participants whose total spent time on the reported physical activities was less than 8 hours or over 24 hours were excluded from the analysis. We calculated the time based on the physical activity intensity distribution we observed for each reported activity using the accelerometer in Hiri and Asaro. The accelerometer underestimates the intensity of physical activities that involve upper body movement and those with minimal vertical displacement and does not capture the extra energy cost of load-bearing activities.

Table 10-16. Percentage of participants meeting WHO's recommendation on physical activity for the prevention of NCDs*

Site	Male			Female		
	No.	Vigorous physical activity≧75 min/w or Moderate physical	Vigorous physical activity≧150 min/w or Moderate physical	No.	Vigorous physical activity≧75 min/w or Moderate physical	Vigorous physical activity≧150 min/w or Moderate physical
Hiri	66	63.6%	47.0%	77	37.7%	22.1%
Asaro	87	86.2%	70.1%	83	84.3%	72.3%
Karkar	56	46.4%	21.4%	74	52.7%	39.2%
Overall	**209**	**68.4%**	**49.8%**	**234**	**59.0%**	**45.3%**

*Analysis restricted to participants aged 18 years or older.

The World Health Organisation (WHO) recommends adults aged 18 years and above to perform at least 150 minutes of moderate-intensity aerobic physical activity throughout the week, or do at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week, or an equivalent combination of moderate- and vigorous-intensity activity to reduce the risk of NCDs. WHO further recommends adults of this age group to perform more than 300 minutes of moderate-intensity aerobic physical activity per week, or 150 minutes of vigorous- intensity aerobic physical activity per week, or an equivalent combination of moderate- and vigorous-intensity activity for additional health benefits (World Health Organization, 2010: http://whqlibdoc.who.int/publications/2010/9789241599979_eng.pdf?ua=1). Table 16 (previous page) presents the percentage of participants meeting these WHO recommendations for the prevention of NCDs. As shown, the highest percentage of both males and females meeting the specified WHO criteria are from Asaro (86.2%, 70.1% & 84.3%, 72.3%, respectively). Conversely, the iHDSS with the lowest percentage of participants meeting these criteria were Karkar for males (46.4% & 21.4%) and Hiri for females (37.7% & 22.1%). The inter-site variation reached a level of statistical significance on both measures for both males and females (Male: $p<0.001$ & $p<0.00$, respectively; Female: $p<0.001$ & $p<0.001$, respectively).

History of Non-Communicable Disease (NCD)

Table 17 presents the percentage of participants' reporting a history of selected NCDs. All questions pertained to lifetime history of disease. Overall, few participants reported having received any form of NCD diagnosis from a health worker especially in the Asaro and Karkar iHDSS. Among those that had, diagnoses of high blood pressure/hypertension and chronic lung disease, COPD or asthma were most commonly reported. Inter-site variation in participant responses failed to reach a level of statistical significance on all items.

Table 18 presents the percentage of participants' reporting an experience of specified NCD- related symptoms. Pain or discomfort in the chest when walking, hurrying or walking uphill is considered indicative of heart disease. Shortness of breath during rest, coughing or wheezing for greater than 10 minutes or coughing up sputum/phlegm most days during a three month period are considered indicative of lung disease. Statistically significant inter-site variation was identified for two symptoms: pain in chest when walking ($p<0.001$); and pain in chest when hurrying or walking up hill ($p<0.001$).

Table 10-17. Self-reported history of selected non-communicable diseases (NCDs)

Site	No.	% (95% CI) of participants' who report having been told by a health worker that they have/have had…						
		Stroke	Heart disease	High blood sugar /diabetes	Chronic lung dis. /COPD/asthma	High blood press/ hypertension	High cholesterol	Cancer
Hiri	263	1.1 (0.2, 3.3)	1.5 (0.4, 3.8)	1.9 (0.6, 4.3)	4.2 (2.1, 7.3)	7.6 (4.7, 11.5)	0.4 (<0.1, 2.1)	0.4 (<0.1, 2.1)
Asaro	249	0 (0, 0)	0 (0, 0)	0 (0, 0)	2.4 (0.9, 5.1)	2.9 (1.1, 6.2)	0 (0, 0)	0 (0, 0)
Karkar	248	0 (0, 0)	0 (0, 0)	0 (0, 0)	2.4 (0.9, 5.2)	0.4 (0.01, 2.2)	0 (0, 0)	0.4 (<0.1, 2.2)
Overall	**760**	**0.4 (0.08, 1.1)**	**0.5 (01, 1.3)**	**0.7 (0.2, 1.5)**	**3.0 (1.9, 4.5)**	**3.7 (2.5, 5.4)**	**0.1 (<0.1, 0.7)**	**0.3 (0.03, 0.9)**

Table 10-18. Self-reported experience of NCD-related symptoms by iHDSS and overall

Site	No.	% (95% CI) of participants' reporting the following symptoms					
		Sudden weakness or paralysis on one side of body for 24+ hours	Experience pain in chest when walking	Experience pain in chest when hurrying or walking uphill	Experience shortness of breath when resting	Experience coughing or wheezing for 10+ minutes	Coughed up sputum or phlegm most days in past 3 months
Hiri	266	9.4 (6.2, 13.6)	27.0 (21.7, 32.9)	21.4 (16.5, 26.9)	7.5 (4.7, 11.4)	11.7 (8.1, 16.2)	5.3 (2.9, 8.8)
Asaro	253	0.8 (<0.01, 2.9)	6.1 (3.4, 9.8)	13.6 (9.6, 18.5)	3.1 (1.4, 6.1)	3.9 (1.9, 7.1)	0.8 (<0.01, 2.8)
Karkar	202	0 (0, 0)	0.8 (0.1, 3.0)	0.4 (<0.01, 2.3)	0.4 (<0.01, 2.2)	0.8 (<0.01, 2.8)	0.8 (<0.01, 2.8)
Overall	**770**	**3.5 (2.3, 5.1)**	**11.6 (9.4, 14.2)**	**12.0 (9.7, 14.5)**	**3.8 (2.5, 5.4)**	**5.6 (4.1, 7.4)**	**2.3 (1.4, 3.7)**

Physical Measurements

Mean participant heights (centimetres), weights (kilogram) and body mass index (BMI) are presented by sex and across sites in Tables 19 and 20, respectively. Inter-site variation reached levels of statistical significance on all measures: Weight male (p<0.001); weight female (p<0.001); height male (p<0.001); height female (p<0.001); BMI male (p<0.001); BMI female (p<0.001); BMI combined (p<0.001).

Table 10-19. Mean participant height and weight by sex

Site	Male			Female		
	No.	Height (cm) Mean (SD)	Weight (kg) Mean (SD)	No.	Height (cm) Mean (SD)	Weight (kg) Mean (SD)
Hiri	113	168.3 (7.5)	70.4 (14.0)	152	158.2 (5.9)	66.7 (18.1)
Asaro	128	162.0 (5.9)	62.2 (8.8)	124	153.3 (5.1)	57.2 (12.7)
Karkar	116	160.8 (6.8)	54.8 (9.2)	135	152.1 (5.4)	50.7 (12.4)
Overall	**357**	**163.6 (7.5)**	**62.4 (12.5)**	**411**	**154.7 (6.1)**	**58.6 (16.3)**

Table 10-20. Mean Body Mass Index (BMI) by sex

Site	Male		Female		Combined	
	No.	Mean (SD)	No.	Mean (SD)	No.	Mean (SD)
Hiri	112	24.5 (5.3)	152	26.6 (6.9)	264	25.7 (6.0)
Asaro	128	23.7 (2.6)	124	24.4 (5.7)	252	24.0 (4.4)
Karkar	115	21.1 (2.9)	134	21.9 (4.7)	249	21.6 (4.0)
Overall	**355**	**23.1 (3.6)**	**410**	**24.4 (6.2)**	**765**	**23.8 (5.2)**

Table 21 presents a breakdown of participants' body mass index (BMI) by category. Underweight was defined as a BMI <18.5, normal weight defined as a BMI between >18.5 and <25, overweight as a BMI between 25 and <30 and obese as a BMI 30+. The highest levels of overweight or obese were among adults from Hiri iHDSS and lowest in Karkar (46.8% and 10.8% of participants, respectively). Inter-site variation reached a level of statistical significance (p<0.001).

Table 10-21 Percentage of participants in each BMI category

Site	No.	BMI classification			
		Underweight % (95% CI)	Normal % (95% CI)	Overweight % (95% CI)	Obese % (95% CI)
Hiri	265	6.8 (4.1, 10.5)	46.4 (40.3, 52.6)	24.5 (19.5, 30.2)	22.3 (17.4, 27.8)
Asaro	252	4.0 (1.9, 7.2)	66.3 (60.1, 72.1)	23.4 (18.3, 29.1)	6.3 (3.7, 10.1)
Karkar	250	12.4 (8.6, 17.1)	76.8 (71.1, 81.9)	8.0 (5.0, 12.1)	2.8 (1.1, 5.7)
Overall	**767**	**7.7 (5.9, 9.8)**	**62.8 (59.3, 66.3)**	**18.8 (16.1, 21.7)**	**10.7 (8.6, 13.1)**

Table 22 presents the mean Waist-to-Hip Ratio (WHR) by sex and Table 23 presents the percentage of participants meeting World Health Organisation criteria for a 'substantially increased' risk of metabolic complications based on WHR measurement (0.85 in females and0.9 in males). Mean WHRs were highest for both males and females from Asaro (0.97 and 0.91, respectively) and lowest for both males and females from Hiri (0.89 and 0.88, respectively). Inter-site variation in mean WHR reached statistical significance for males, but not females (p<0.001 & p=0.0532, respectively).

Similarly, a greater percentage of both males and females from Asaro iHDSS met the WHO criteria for substantially increased risk of metabolic complications based on WHR as compared to males and females from other sites (97.7% and 82.0%, respectively). Inter-site variation on this measure reached levels of statistical significance for both sexes (male p<0.001; female p<0.001; combined p<0.001).

Table 10-22. Mean waist-to-hip ratio by sex

Site	Male		Female		Combined	
	No.	Mean (SD)	No.	Mean (SD)	No.	Mean (SD)
Hiri	112	0.89 (0.08)	152	0.88 (0.14)	264	0.88 (0.12)
Asaro	128	0.97 (0.05)	122	0.91 (0.10)	250	0.94 (0.08)
Karkar	111	0.90 (0.07)	133	0.90 (0.05)	244	0.90 (0.06)
Overall	**351**	**0.92 (0.08)**	**407**	**0.89 (0.10)**	**758**	**0.91 (0.09)**

Table 10-23. Percentage of participants meeting WHO criteria for 'substantially increased' risk of metabolic complications based on waist-to-hip ratio (Females ≥0.85; Males ≥0.9)

Site	Male		Female		Combined	
	No.	% (95% CI)	No.	% (95% CI)	No.	% (95% CI)
Hiri	112	44.6 (35.2, 54.3)	152	57.9 (49.6, 65.8)	265	52.1 (45.9, 58.2)
Asaro	128	97.7 (93.3, 99.5)	122	82.0 (74.0, 88.3)	254	88.6 (84.0, 92.2)
Karkar	111	38.7 (29.6, 48.5)	133	81.2 (73.5, 87.5)	244	61.9 (55.5, 68.0)
Overall	**351**	**62.1 (56.8, 67.2)**	**407**	**72.7 (68.1, 77.0)**	**763**	**67.4 (63.9, 70.7)**

Blood Pressure

Tables 24 and 25 present participants' mean resting systolic and diastolic blood pressure readings based on the average of three consecutive reads taken at least one minute apart. Mean blood pressure was highest on both measures for males from Hiri IHDSS (130.3 and 79.2) and females from Asaro iHDSS (124.6 and 78.0). Inter-site variation reached levels of statistical significance on both measures for both males and females: Systolic male (p<0.001); systolic female (p<0.001); systolic combined (p<0.001); diastolic male (p<0.001); diastolic female (p<0.001); diastolic combined (p<0.001).

Table 10-24. Mean resting systolic blood pressure by sex

Site	Male		Female		Combined	
	No.	Mean (SD)	No.	Mean (SD)	No.	Mean (SD)
Hiri	112	130.3 (16.9)	152	122.3 (21.2)	264	125.7 (19.8)
Asaro	115	128.7 (17.0)	107	124.6 (16.5)	222	126.7 (16.8)
Karkar	117	120.2 (12.3)	135	113.8 (13.6)	252	116.8 (13.3)
Overall	**344**	**126.3 (16.1)**	**394**	**120.1 (18.2)**	**738**	**123.0 (17.5)**

Table 10-25. Mean resting diastolic blood pressure by sex

Site	Male		Female		Combined	
	No.	Mean (SD)	No.	Mean (SD)	No.	Mean (SD)
Hiri	112	79.2 (12.5)	152	75.4 (12.2)	264	77.0 (12.4)
Asaro	115	78.7 (9.9)	107	78.0 (9.4)	222	78.4 (9.7)
Karkar	117	71.1 (8.1)	135	70.4 (8.8)	252	70.7 (8.5)
Overall	**344**	**76.3 (10.9)**	**394**	**74.4 (10.8)**	**738**	**75.3 (10.9)**

Table 26 presents the percentage of participants meeting criteria for hypertension, defined as systolic blood pressure ≥140 and/or diastolic blood pressure ≥ 90. Among males, 28.6% of participants from Hiri met the criteria for hypertension as compared to 4.3% from Karkar. Among females, the highest percentage was recorded in Asaro (17.8%) and the lowest in Karkar (5.3%). The inter-site variation reached levels of statistical significance for males, but not females: male (p=0.003); female (p=0.139); combined (p<0.001).

Table 10-26. Percentage with hypertension (SBP ≥140 and/or DBP ≥90) by sex

Site	Male		Female		Combined	
	No.	% (95% CI)	No.	% (95% CI)	No.	% (95% CI)
Hiri	112	28.6 (20.4, 37.9)	152	17.1 (11.5, 24.0)	264	22.0 (17.1, 27.5)
Asaro	115	24.3 (16.8, 33.2)	107	17.8 (11.0, 26.3)	222	21.2 (16.0, 27.1)
Karkar	117	4.3 (1.4, 9.7)	135	5.2 (2.1, 10.4)	252	4.8 (2.5, 8.1)
Overall	**344**	**18.9 (14.9, 23.4)**	**394**	**13.2 (10.0, 16.9)**	**738**	**15.9 (13.3, 18.7)**

Heart Rate

Mean heart rate by sex is presented in Table 27 (based on mean of three reads of resting pulse rate at least one minute apart). The highest mean pulse rates were recorded in Hiri iHDSS for both male and female participants (73.6 and 78.4, respectively) and the lowest in Asaro (66.5and 73.3%, respectively). Inter-site variation in mean pulse rate was statistically significant: male (p<0.001); female (p<0.001); combined (p<0.001).

Table 10-27. Mean heart rate – beats per minute – by sex

Site	Male		Female		Combined	
	No.	Mean (SD)	No.	Mean (SD)	No.	Mean (SD)
Hiri	112	73.6 (10.8)	152	78.4 (9.9)	264	76.4 (10.5)
Asaro	115	66.5 (10.6)	107	73.3 (11.3)	222	69.8 (11.4)
Karkar	117	69.2 (9.4)	135	75.3 (10.7)	252	72.4 (10.6)
Overall	**344**	**69.7 (10.7)**	**394**	**76.0 (10.7)**	**738**	**73.1 (11.1)**

Lung Function

A total of 509 valid lung function results were obtained from study participants of which 49.9% met criteria for abnormal lung function (FEV1/FVC<0.7; Table 28). A higher percentage of male and female participants from the Hiri and Asaro iHDSS produced abnormal lung function results as compared to Karkar; however, inter-site variation did not reach levels of statistical significance for either sex or the combined sample: male (p=0.150); female (p=0.155); combined (p=0.0258).

Table 10-28. Percentage of participants meeting criteria for 'abnormal' lung function (FEV1/FVC <0.7)

Site	Male		Female		Combined	
	No.	% (95% CI)	No.	% (95% CI)	No.	% (95% CI)
Hiri	62	48.4 (35.5, 61.4)	96	63.5 (53.1, 73.1)	158	57.6 (49.5, 65.4)
Asaro	100	49.0 (38.9, 59.2)	101	53.5 (43.3, 63.5)	201	51.2 (44.1, 58.3)
Karkar	73	32.9 (22.3, 44.9)	77	46.8 (35.3, 58.5)	150	40.0 (32.1, 48.3)
Overall	**235**	**43.8 (37.4, 50.4)**	**274**	**55.1 (49.0, 61.1)**	**509**	**49.9 (45.5, 54.3)**

Anaemia

Table 29 presents the percentage of participants meeting the World Health Organisation (WHO) criteria for anaemia (female Hb ≤12.0 g/dL and male ≤13.0 g/dL). Anaemia was most prevalent among both male and female participants from Karkar iHDSS (67.0% and 75.4%, respectively) and lowest overall in Asaro (24.4%). Inter-site variation reached levels of statistical significance for males (p<0.001), females (p<0.001) and the combined sample (p<0.001).

Table 10-29. Percentage meeting WHO criteria for anaemia (female Hb ≤12.0 g/dL and male≤13.0 g/dL).

Site	Male		Female		Combined	
	No.	% (95% CI)	No.	% (95% CI)	No.	% (95% CI)
Hiri	112	17.0 (10.5, 25.2)	150	47.3 (39.1, 55.6)	261	34.1 (28.4, 40.2)
Asaro	118	21.2 (14.2, 29.7)	117	27.4 (19.5, 36.4)	234	24.4 (19.0, 30.4)
Karkar	115	67.0 (57.6, 75.4)	134	75.4 (67.2, 82.4)	247	71.7 (65.6, 77.2)
Overall	**345**	**35.1 (30.0, 40.4)**	**401**	**50.9 (45.9, 55.9)**	**742**	**43.5 (39.9, 47.2)**

Haemoglobin A1c

Haemoglobin A1c (HbA1c) is a measure of the percent of glucose in the blood stream. A HbA1c result of less than 5.7% is considered 'normal', 5.7% to 6.4% is considered pre- diabetic (i.e. 'at risk' of developing diabetes mellitus type 2) and 6.5% or more is considered diagnostic of diabetes. Table 30 presents HbA1c results by iHDSS. Overall, 18.7% of participants had blood glucose levels in the pre-diabetic (15.1%) or diabetic (3.6%) range. Prevalence was highest in the Hiri iHDSS where 34.5% of adult participants tested in the pre- diabetic (25.3%) or diabetic (9.2%) range. Inter-site variation in the proportion of participants in each HbA1c category reached a level of statistical significance (p=0.001).

Table 10-30. Percentage of participants' with HbA1c results in the pre-diabetic (5.7% to 6.4%) or diabetic (6.5%+) range.

Site	No.	HbA1c result	
		Pre-diabetic % (95% CI)	Diabetic % (95% CI)
Hiri	261	25.3 (20.1, 31.0)	9.2 (6.0, 13.4)
Asaro	220	11.8 (7.9, 16.8)	0 (0, 1.6)
Karkar	240	7.1 (4.2, 11.1)	0.8 (0.01, 3.0)
Overall	**721**	**15.1 (12.6, 17.9)**	**3.6 (2.4, 5.2)**

Lipid Profile

Elevated cholesterol and triglycerides are known risk factors for cardiovascular disease. The percentage of participants with elevated levels of these respective lipids are presented in Table 31. As shown, 17.7% of all participants had elevated cholesterol levels and 32.6% elevated triglyceride levels. Inter-site variation reached a level of statistical significance for both elevated cholesterol (p=0.005) and elevated triglycerides (p<0.001).

Table 10-31. Percentage of participants' meeting criteria for elevated cholesterol (>6.2mmol/L) and elevated triglycerides (>2. 3mmol/L)

Site	No.	Elevated cholesterol	Elevated triglycerides
		% (95% CI)	% (95% CI)
Hiri	265	23.4 (18.4, 29.0)	43.6 (37.5, 49.8)
Asaro	218	16.1 (11.4, 21.6)	35.3 (29.0, 42.1)
Karkar	219	12.3 (8.3, 17.4)	16.8 (12.1, 22.4)
Overall	**702**	**17.7 (14.9, 20.7)**	**32.6 (29.2, 36.2)**

Microalbuminuria

Tables 32 and 33 presents the percentage of participants with microalbuminuria and with abnormally high microalbuminuria levels, respectively. As shown, 63.5% of participants had microalbuminuria and 2.8% had abnormally high microalbuminuria levels. Statistically significant inter-site variation was identified on both measures with respect to males (p<0.001& p=0.017, respectively), females (p<0.001 & p=0.023, respectively) and the combined sample (both p<0.001).

Table 10-32. Percentage of participants with microalbuminuria present (males = albumin/creatinine ratio (ACR) ≥2.5mg/mmol; females = ACR ≥3.5mg/mmol)

Site	Male		Female		Combined	
	No.	% (95% CI)	No.	% (95% CI)	No.	% (95% CI)
Hiri	89	86.5 (77.6, 92.8)	132	91.7 (85.6, 95.8)	121	89.6 (85.0, 93.3)
Asaro	109	92.7 (86.0, 96.8)	109	86.2 (78.3, 92.1)	218	89.4 (84.6, 94.2)
Karkar	92	6.5 (2.4, 13.7)	110	7.3 (3.2, 13.8)	202	6.9 (3.8, 11.4)
Overall	**290**	**63.4 (57.6, 69.0)**	**351**	**63.5 (58.3, 68.6)**	**641**	**63.5 (59.6, 67.2)**

Table 10-33. Percentage of participants with abnormally high microalbuminuria levels (males ACR >25 mg/mmol; females ACR >35 mg/mmol)

Site	**Male**		**Female**		**Combined**	
	No.	**% (95% CI)**	**No.**	**% (95% CI)**	**No.**	**% (95% CI)**
Hiri	89	5.6 (1.8, 12.6)	132	6.8 (3.2, 12.5)	221	6.3 (3.5, 10.4)
Asaro	109	0.9 (0.02, 5.0)	109	1.8 (0.2, 6.5)	218	1.4 (0.3, 4.0)
Karkar	92	0 (0, 3.9)	110	0.9 (0.02, 5.0)	202	0.5 (0.01, 2.7)
Overall	**290**	**2.1 (0.8, 4.4)**	**351**	**3.4 (1.8, 5.9)**	**641**	**2.8 (1.7, 4.4)**

10.4 DISCUSSION

This report presents key findings from a survey of NCDs and associated risk factors in the general adult populations of the Hiri, Asaro Valley and Karkar Island iHDSS. The data were collected during the construction phase of the Exxon Mobil led PNG LNG project. As such, the reported findings serve as a baseline of NCD prevalence and associated risk factors in the initial years of a PNG LNG project impact site (Hiri) and in two non-project impact communities (Asaro and Karkar) in the period immediately prior to anticipated accelerated growth in PNG's gross domestic product (as a result of the PNG LNG project). The three study populations were comparable in terms of participant age and gender; however, the Hiri participant population was better educated and more likely to be in paid employment as compared to participants' from Asaro and Karkar. These differences in education and employment were expected and reflect the different socioeconomic contexts of the three iHDSS. A multitude of differences in the prevalence of NCD risk factors were also observed across

sites (discussed in more detail below) and no one site had a consistently higher or lower prevalence of each risk factor assessed. The study findings will be discussed in the context of each iHDSS below and then an overall summary presented.

Hiri iHDSS

Food consumption data for Hiri indicate a diet low in root vegetables, green vegetables and fruits (consumed on a median of 2, 1 and 1 days per week, respectively) and a comparatively high consumption of fresh- and tinned-meats (consumed on a median of 4 and 5 days per week, respectively). Food insecurity was widely perceived to be a problem in the Hiri iHDSS (44.8% of participants) and those participants who reported perceived food insecurity considered it to be a more frequent occurrence in Hiri as compared to other iHDSS. Hiri participants were the least likely to be daily smokers (36.5%), although not at a statistically significant level; however, buai consumption was highest in Hiri (93.5%) as was alcohol consumption over the past 12-months or 30-days (58.3% & 45.1%, respectively). Hiri smokers most commonly smoked manufactured cigarettes and the use of brus (home grown tobacco) was not reported. Hiri participants were, on average, taller and heavier than their counterparts from Asaro and Karkar and were more likely to be overweight (24.5%) or obese (22.3%) based on BMI criteria. Nevertheless, across all three iHDSS the mean waist-to-hipratio (WHR) was lowest among Hiri participants who were also the least likely to meet WHR-based criteria for a substantially increased risk of metabolic complications. This raises the possibility that the higher mean BMI among Hiri participants may reflect differences in body mass composition rather than greater body fat per se.

Few Hiri participants reported a history of NCD disease or any experience of NCD-related symptoms, a majority (62.6%) rated their general health as 'good' and most thought their health was 'the same as' (63%) or 'better than" (30.5%) others. However, of the seven clinical indicators of NCD risk presented in this report, six were highest among Hiri participants, including: hypertension (22%), abnormal lung function (57.6%), HbA1c (25.3% pre-diabetic, 9.2% diabetic), microalbuminuria (89.6%), elevated cholesterol (23.4%) and elevated triglycerides (43.6%). Collectively, these findings indicate that out of the three iHDSS included in this survey Hiri has the greatest NCD burden and/or is the population most at risk of developing a high NCD burden.

Asaro iHDSS

Food consumption data indicate ready access to the root- and green-vegetables associated with a subsistence farming lifestyle. However, consumption of either fresh or tinned meat was lowest in Asaro (median of 1 and 2 days per week, respectively) and the median consumption of fats, sugars and salts was higher than the peri-urban Hiri population. Perceived food insecurity was also highest in Asaro iHDSS (64.3%). Prevalence of daily smoking (41%) was in-between that of Hiri and Karkar (31.5% & 50.5%, respectively), buai consumption (55.1%) was the lowest of the three iHDSS and alcohol consumption over the past 12-months (40.4%) or 30-days (22.9%) was substantially higher than Karkar (19.6% & 7.1%, respectively) and closer to that of Hiri. Mean height and weights were middling of the three iHDSS as was BMI, although 88.6% of participants from Asaro had a WHR indicative of a substantial risk of metabolic complications. This was the highest percentage among the three iHDSS and suggests the Asaro (Highlands) population may be particularly susceptible to a build-up of abdominal adipose tissue. Asaro participants most commonly rated their own general health as 'moderate' (42.5%) or 'bad' (42.9%), even though very few reported any history of NCD

disease or NCD-related symptoms. Consistent with this common perception of poor health, many of the clinical indictors were comparable to the high risk Hiri population: the prevalence of hypertension (21.2%) was only marginally lower than in Hiri(22%) and substantially higher than Karkar (4.8%) and close to a quarter of participants had elevated cholesterol or triglyceride levels (16.1%, and 35.3%, respectively). Abnormal lung function and microalbuminuria were also particularly high among Asaro Valley participants (51.2% & 89.4%, respectively), although HbA1c results indicative of diabetes were absent (0%). These findings are indicative of a high risk of cardiovascular and respiratory disease, and at a level similar to Hiri iHDSS, but lower risk of type II diabetes mellitus at present.

Karkar iHDSS

Food consumption data indicated a healthier diet among Karkar iHDSS participants as compared to their Hiri and Asaro peers. Root- and green-vegetables were consumed on a median of seven days of the week, fresh meat was consumed a median of two days per week and consumption of fats, sugars and salts were rarely reported. Furthermore, only 6.9% of participants perceived any food shortages in the community, a level significantly lower than Hiri or Asaro. Karkar did report the highest percentage of daily smokers (50.5%), almost all of whom exclusively smoked brus (95.6%), and a high percentage (86.5%) chewed buai within the past 30 days; however, alcohol consumption was the lowest among all three iHDSS with only 19.6% reporting alcohol use in the past 12-months and 7.1% alcohol use in the past 30 days. Mean heights and weights were lowest among Karkar participants as was the mean BMI with only 10.8% of participants overweight (8%) or obese (2.8%), although 61.9% had a WHR indicative of a substantially increased risk of metabolic complications. Karkar participants generally considered themselves to be healthy with 69.8% rating their own health as 'excellent' and only 4.8% reporting a current *wari* or *hevi*. This self-perception of good health was (to a certain extent) reflected in the clinical indicators with the Karkar sample having the lowest prevalence of: hypertension (4.8%), elevated triglycerides (16.8%), microalbuminuria (6.9%) and abnormal lung function (40%). Prevalence of elevated cholesterol (12.3%) was comparable to Asaro (16.1%) and lower than Hiri (23.4%), as were the percentage of participants with HbA1c results in the pre-diabetic (7.1%) or diabetic (0.8%) range. The only clinical indicator in which Karkar participants had a higher prevalence than their counterparts in other iHDSS was anaemia. Overall, 71.7% of Karkar participants were anaemic as compared to 34.1% and 24.4% in Hiri and Asaro, respectively. Collectively, these data indicate NCD risk was lowest in the Karkar iHDSS, although findings pertaining to smoking prevalence, WHR, cholesterol, lung function and anaemia remain of substantial concern.

Summary

The reported findings indicate a substantial existing NCD burden in the general adult population of Hiri or, in the very least, a population at serious risk of developing a high NCD burden. As few Hiri participants had previously been diagnosed with an NCD and/or reported NCD-related symptoms then, despite the high NCD burden, general population awareness of NCDs and NCD risk factors would appear to be low and current NCD prevention, screening and treatment services inadequate. As study participants from Hiri had the highest level of educational attainment, were more likely to be in paid and professional employment and have ready access to health facilities and programs in the nation's capital (as compared to participants from Asaro and Karkar), then the apparent lack of

NCD awareness in the Hiri general population and inadequate professional support is of particular concern. Higher NCD prevalence in this population is likely to be the result of a number of factors including genetic susceptibility and proximity to Port Moresby. Nevertheless, NCD risk is likely to be further heightened by the economic and lifestyle changes resulting from the PNG LNG project (given its predicted contribution to future Gross Domestic Product) that – due to the presence of both the PNG LNG processing site and proximity to Port Moresby – the Hiri iHDSS population are likely to experience to a greater extent relative to other iHDSS. The reported findings, therefore, indicate an immediate need for NCD prevention, screening and intervention programs in this project impact site.

The reported findings further indicate the NCD burden/risk is lower in Asaro iHDSS as compared to Hiri, although not substantially so. The NCD burden/risk was lowest of all in Karkar iHDSS, although risk factors of considerable concern were still evident in a large proportion of this population. Indeed, risk factors for cardiovascular and respiratory disease were evident in a large proportion of study participants across all sites. The major difference in terms of NCD risk between the peri-urban Hiri population and the rural Asaro and Karkar populations pertained to diabetes. BMI and HbA1c results indicated a substantially higher prevalence and/or risk of diabetes mellitus type II in Hiri as compared to the other sites. The findings from Asaro and Karkar iHDSS' are most likely to be reflective of NCD prevalence and risk in the broader (largely rural) population of PNG. Thus, it is of considerable concern that up to 21.3% and 35.3% of adult participants in these iHDSS had elevated cholesterol or triglycerides (respectively), 7-11% had high blood glucose levels, 40-51.2% had abnormal lung function and up to 21.2% were hypertensive. Few participants (and even fewer than Hiri) reported having received an NCD diagnosis further suggesting current screening and intervention programs may be inadequate or potentially non-existent in these rural populations. In addition, the reported prevalence of NCDs and associated risk factors were substantially higher than those reported in earlier studies from the same or comparable communities [37-42]. For example, Scrimgeour et al [37] found no cases of elevated cholesterol or triglycerides in a randomised cross sectional survey conducted in the Asaro valley in the late 1980s, and Boyce at al reported no cases of hypertension in a cross sectional survey conducted on Karkar island in the late 1970s [38]. The findings from Asaro and Karkar iHDSS', when viewed in the light of these earlier studies, are strongly suggestive of a generalised increase in NCD burden and risk across the country.

The need for prevention, screening and intervention campaigns may be less urgent in Asaro and Karkar relative to Hiri; however, complacency will only exacerbate the future cost of the NCD burden to these communities. Thus, NCD prevention and health promotion campaigns should be prioritised in the short-term across all iHDSS with more intensive screening and intervention programs targeted towards Hiri iHDSS. The particularly high rates of elevated cholesterol and triglycerides as well as hypertension further suggest that cardiovascular disease prevention and treatment may warrant a priority focus across all iHDSS. Prevention and treatment programs pertaining to diabetes mellitus should be prioritised in Hiri. The Asaro and Karkar iHDSS continue to present as especially valuable longitudinal surveillance sites in which the NCD burden and associated risk factors may be closely monitored over time. As suggested, NCD prevalence in these sites is likely to be reasonably representative of rural communities across PNG. The same is less true of the Hiri iHDSS. Such long-term NCD surveillance in the Asaro and Karkar iHDSS would afford some assessment of the impact of NCD prevention campaigns and provide advance warning for the need to scale up screening and intervention programs elsewhere.

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SPECIALTY REPORTS

Sentinel Surveillance

Maternal and Newborn Health

Healthy Pregnancy Study

Tuberculosis

11.0SENTINEL SURVEILLANCE

Project title: Investigation into Febrile, Diarrhoeal and Acute Lower Respiratory Illnesses in Papua New Guinea.

Principle Investigators: Dr Yazid Abdad (PNGIMR, Papua New Guinea), Dr Andrew Greenhill (Federation University, Australia), Dr Paul Horwood (Pasteur Institute, Cambodia).

Staff Involved: Grace Bande, Tobias Maure, Glennis Rai, Janet Totave, Johnson Makaen, John-Paul Matlam.

Summary

The Sentinel Surveillance study as part of the Partnership in Health Programme was conducted as a collaboration between the Environmental and Emerging Diseases Unit (EEDU) and Infection and Immunity Unit of PNGIMR between 2012 and 2014. A large number of molecular diagnostics assays were adopted by PNGIMR to detect the most important febrile, diarrhoeal and respiratory diseases in the region. These assays were evaluated using retrospective samples, thereby generating important information on the aetiology of disease in PNG. Study samples were collected from the four iHDSS sites of Hides, Hiri, Karkar island and Asaro between mid-2012 and 2014. The initial sample collection phase was dedicated to implementing systems and overcoming logistical challenges; with active sample collection commencing in early 2013.

Much of the initial work performed to develop assays was conducted on retrospective samples. These data generated were used to gain insight into the aetiology of diseases investigated. For example, using these data we were able to conclude that causes of respiratory illness in PNG are similar to other countries in the region. On this basis we were able to streamline sample collection and analysis by excluding respiratory sample collection and analysis for the prospective portion of the study.

Malaria continues to be a geographically significant cause of febrile illness in PNG, i.e., location setting is extremely important. In some locations, there were comparatively few non-malarial causes of febrile illness detected. There are multiple causes of respiratory infections and diarrhoea in PNG; with causes of respiratory illness similar to that of other settings. *Shigella* and rotavirus were amongst the commonly detected gastrointestinal pathogens; in keeping worth findings in other low-income settings. Also of note is the important role of *Campylobacter* spp. in patients with diarrhoea.

The sentinel surveillance study provides insight into causes of illness in regional PNG. Factors such as low education, poor sanitation and hygiene, and changing society structures and norms (e.g. more animal husbandry) are likely important impact factors on the health of the regional populations in PNG.

11.1 INTRODUCTION

The role of surveillance as part of health management is to determine the type of diseases and their frequency when circulating among communities and general population. In Papua New Guinea, surveillance of two main causes of mortality and morbidity were investigated, (i) diarrhoeal and (ii) febrile illness. Both diarrheal and febrile illness are commonly found at local health clinics and often account for a substantial percentage of the overall burden of disease encountered at the clinic level. Nevertheless very little is known of causative pathogens for these general disease categories.

11.1.1 Diarrhoeal Illness

Diarrhoeal illness is a serious challenge to developing nations worldwide. Papua New Guinea (PNG) is not exempt from diarrhoeal illness, it being one of the major causes of mortality in PNG. Most diarrhoeal illness is easily preventable with simple hygiene measures and treated with inexpensive treatment regimes. However, with only 40% of the locals having access to safe water supply and adequate sanitation (1), and access to treatment in some regional and remote areas of PNG limited, the burden of diarrhoeal diseases is high.

Recent work by EDDU, some of which has been conducted with the support of PIH, has increased our understanding of diarrhoeal aetiology in PNG (2-10). However much is unknown, particularly for understanding the aetiology of diarrhoeal in young PNG children. Sustainable build-up of capacity to provide accurate diagnosis and assist health workers in providing care and education to communities nation-wide is essential (2).

11.1.2 Febrile Illness

Febrile illness is one of the most common presenting symptoms among patients in hospitals and health centres in tropical developing countries. Febrile illnesses are a major cause of morbidity in Papua New Guinea (PNG). However, an accurate diagnosis of illness is beyond the capacity of the vast majority of diagnostic laboratories in low-income countries, and as such little is known about the aetiology of febrile illness in this setting.

Due to the large range of causes of febrile illness, diagnosis can be a challenge especially for poorly equipped health facilities. In locations where malaria is endemic such as PNG, febrile cases are usually tested for malarial parasites by either a rapid test or microscopy. Malaria is given priority due to its severity, especially in children. However, there are many non-malarial causes of febrile illness. Knowing what proportion of febrile illness can be attributed to malaria has important implications for the implementation of treatment of fever in settings such as PNG. In PNG the prevalence of laboratory or rapid test proven malaria has decline to <2%. Thus, EDDU continues to investigate non-malarial febrile illnesses and contribute to the knowledge base of disease aetiology in PNG (11-15).

11.1.3 Respiratory Illness

Acute lower respiratory infections (ALRI) are the leading cause of morbidity and mortality in children worldwide, resulting in an estimated 4 million deaths annually (16). This equates to approximately 20% of all childhood deaths, the majority of which occur in developing countries (17). In Papua New Guinea ALRI is the most common cause of hospitalization for children under the age of 1 years and the second most common cause of hospitalization for children 1-4 years of age (18).

ALRI can be caused by many different aetiologies, including numerous species of bacteria, virus, protozoa and fungi. Although bacterial pathogens, in particular Haemophilus influenzae and Streptococcus pneumoniae, are identified as the major cause of ALRI - viral agents are also considered important agents in the disease process. Various studies have identified viral species as the aetiological agent of ALRI in 20–48% of cases examined (19-22). In addition to causing primary pneumonia, viruses also damage the mucosal layer of the respiratory tract and therefore predispose the onset of secondary bacterial pneumonia. Numerous studies have shown that co-infections with bacterial and viral respiratory pathogens cause more severe disease. De Roux et al (23)found that people with a mixed infection (viral and bacterial) were at increased risk of sepsis or septic shock.

Although ALRIs result in a high degree of morbidity and mortality, the aetiological agent is often unidentified. Conventional culture and serological methods are time consuming and often suffer from poor sensitivity. Some viral agents are unable to be grown in culture due to the unavailability of a suitable cell line to support their growth. Molecular diagnostics such as PCR offer the potential for improved diagnosis of respiratory viruses, but their uptake in low-income settings such as PNG has been limited to date. Typically, if molecular diagnostics are present in low-income countries they are restricted to a small number of reference laboratories.

11.1.4 Study Objectives

As part of the Partnership in Health Programme between Papua New Guinea Institute of Medical Research (PNGIMR) and ExxonMobil PNG Ltd, a sentinel surveillance programme was initiated as a sub-study of the PiHP in order to investigate the aetiology of the three illness types at iHDSS locations. The Sentinel Surveillance (SS) study was designed as a stand-alone separate study, independent of other sub-studies, including the Morbidity Surveillance study. The data collected is independent of other studies conducted within the PiHP programme due to the inclusion of patients not recruited in other sub-studies. Nevertheless the SS provide an important cross-check for clinic reported data which are largely made without laboratory confirmation.

To determine the aetiological agents involved in febrile, diarrhoeal and acute lower respiratory illnesses in Papua New Guinea, we established the following objectives:

- Use molecular diagnostic methods to investigate clinical samples from patients with febrile, diarrhoeal and acute lower respiratory illnesses of unknown aetiology.
- Design and evaluate sensitive multiplex assays and modern molecular techniques specific to the disease agents involved in the presentation of febrile, respiratory and diarrhoeal illnesses in PNG.
- Investigate and diagnose febrile, diarrhoeal and acute lower respiratory illnesses from iHDSS coverage health clinics.

11.2 METHODS

11.2.1 Development of new assays

Various new assays were developed for the sentinel surveillance study programme. Only results from assays directly giving results to the disease aetiologies investigated are reported. Through this study EDDU has adopted a large number of molecular assays, which will allow for the detection of a wide range of pathogens for the first time in PNG, including assays to detect 15 respiratory viruses,

19 enteric pathogens and 16 febrile pathogens. The adoption of these assays in PNGIMR laboratories is an important step in increasing capacity in the country for surveillance, research and outbreak investigations. For a list of assays developed, see Appendix I.

11.2.2 Testing of retrospective samples using new assays

Assays developed for the study were tested on retrospective samples stored at PNGIMR from other related/overlapping studies. Results obtained from these sub-projects were published in peer-reviewed journals. For a list of publications published related to the study, see Appendix II.

Acute Watery Diarrhoea in a Paediatric Population

The aetiology of acute watery diarrhoea (AWD) was investigated from patients recruited through routine rotavirus surveillance at Goroka General Hospital. Stool samples collected from 199 children (age < 5 years) admitted to the paediatric ward of Goroka General Hospital from August 2009 through November 2010 were tested for a large range of viral and bacterial enteric pathogens using real-time PCR assays adopted through the PiH project. Children were considered eligible for inclusion in the study if their parent/guardian reported acute watery diarrhoea (>3 loose bowel movements in the last 24 h) and no blood or mucous was observed in the faeces. Eluates from the stool samples were tested for a range of viral and bacterial enteric pathogens using real-time PCR assays (Appendix II). RNA viruses (rotavirus, norovirus G1 and G2, sapovirus, and astrovirus) were detected in individual reactions using the QuantiTect Multiplex Real-Time RT-PCR Mastermix (Qiagen, Germany). DNA viruses (adenovirus types 40/41) and bacteria (Shigella spp, Salmonella spp, Vibrio cholerae, Campylobacter spp, enteropathogenic Escherichia coli (EPEC) and enterotoxigenic E. coli (ETEC)) were detected in individual reactions using the QuantiTect Multiplex Real-Time PCR Mastermix (Qiagen, Germany).

Evaluation of Rapid Diagnostic Methods for the Detection of Enteric Pathogens

Loop-mediated isothermal amplification (LAMP) is a nucleic acid amplification test that show great promise in developing countries.Single-temperature amplification and colorimetric detection methods greatly reduce the system complexity of PCR-based methods, while maintaining many of the advantages of nucleic acid amplification methods. We evaluated the sensitivity of LAMP colorimetric detection methods for Salmonella, Shigella, and Vibrio cholerae. Previously published LAMP assays were utilised with different end-point detection methods, namely, visual turbidity (as indicated by the formation of a white precipitate), hydroxynaphthol blue (HNB), SYBR Green I, and readings from the Loopamp Endpoint Turbidimeter (Teramecs Co. Ltd., Kyoto, Japan). The assays were also compared to real-time PCR assays using previously published primers. Serially diluted clinical strains of Salmonella enteric serovarTyphi, Shigella flexneri, and V. cholerae, obtained through clinical studies conducted in our laboratory, were used to compare the assays.

The Aetiology of Influenza-Like-Illness in the Eastern Highlands

The aetiological agents associated with influenza-like-illness were investigated retrospectively for 300 nasopharyngeal swabs received by the Papua New Guinea National Influenza Centre in 2010. Real-time PCR methods were used for the detection of 13respiratory viruses. Patients with influenza-like-illness were identified according to the World Health Organization case definition: sudden onset of fever (>38°C), with cough and/or sore throat, in the absence of other diagnoses. The samples

were screened for a large range of respiratory viruses which have previously been associated with influenza-like-illness. All viruses were detected using individual Taqman real-time PCR assays. RNA viruses (influenza A, influenza B, HRSV, HPIV-1, HPIV-2, HPIV-3, HCoV-229E, HCoV-OC43, HCoV-NL63, HCoV-HKU1, HMPV, and HRV) were detected using the QuantiTect Multiplex RT-PCR Master Mix (Qiagen) and the DNA viruses (HAdV) were detected using the QuantiTect Multiplex PCR Master Mix (Qiagen). All reactions and cycling conditions were conducted according to the master mix manufacturer's instructions.

The Aetiology of Febrile Illnesses in Western Province

EDDU investigated the aetiological agent of febrile illnesses through retrospective testing of 136 people presenting to Wipim Health Centre in Western Province (South Fly district), Papua New Guinea. Arboviral and rickettsial real-time PCR assays, malaria blood smears and a malaria PCR test were used to detect pathogens from samples of patients with a history of fever. The samples were collected during active malaria surveillance as part of an evaluation of the National Malaria Control Program by the PNGIMR covering a period of 7 weeks, between April and June 2009. During this period, 136 patients presented to the clinic with a self-reported history of fever within the previous three days. A malaria blood slide was completed and a dried blood spot sample on filter paper was sent to the PNGIMR laboratory in Goroka for further analysis. The presence of a malaria infection was confirmed using a semi-quantitative post-PCR, ligase detection reaction/fluorescent microsphere assay. Previously published real-time PCR primers and probes were used to test for a large range of arboviral and rickettsial species (Appendix II).

Investigation Into the Febrile Illness Outbreak in Vanimo, Sandaun Province

In late June 2012, an increase in cases of prolonged fever for ≥3 days was reported from the Vanimo General Hospital in Vanimo, Sandaun Province. The illness was characterized by high fever (temperature >40°C), arthralgia, emesis, and severe nausea. In most patients, fever subsided within 24–72 hours and patients were discharged after abatement of initial signs and symptoms. However, many patients returned within a few days reporting lingering arthralgia and severe pruritus. On the basis of clinical characteristics, several arboviruses were immediately suspected as causes of the illness. EEDU was asked to investigate the outbreak by the NDoH and WHO. Serum samples were collected from 86 patients with acute fever during September–October 2012. Samples were screened for Chikungunya virus (CHIKV), dengue virus (DENV) and rickettsials by using previously published real-time PCR assays.

Collection and testing of samples from iHDSS sites

Samples were collected from health clinics participating in the iHDSS coverage area. Patients presenting to the clinics with febrile illness over 38°C were tested for malaria using a commercial rapid test. Regardless of the result, a blood sample was taken for further analysis. If the febrile patient was also showing respiratory symptoms a nasal swab sample was taken for respiratory pathogen screening. Patients presenting to the health clinics with a diarrhoeal illness were asked to provide a faecal sample. If a patient presented with a combination of symptoms (e.g. febrile illness with diarrhoeal and respiratory symptoms) then multiple samples were requested. All of the required sampling materials were provided by PNGIMR including detailed information sheets for the health-care practitioners to complete.

Case definition of diarrhoea - the passing of three or more loose stools (which take the shape of the container), in a 24 hour period.

Self-collected stool specimens were obtained from patients presenting to participating HDSS clinics with acute diarrhoea meeting the case definition. Specimens were labelled appropriately and linked to the HDSS Morbidity Case Forms for identification of clinical history. Samples were stored at 4°C and transported to the PNGIMR laboratories for further analysis.

Bacterial stool culture and microscopic examination for parasitic pathogens were conducted according to standard procedures. Nucleic acids were extracted from the stool samples using the Qiagen Stool kit and molecular analysis using real-time PCR was conducted for the enteric pathogens listed in Table 9.1.

Case definition of a febrile illness - a current fever of ≥38°C, OR reports a fever over the past 2 days (but not more than 2 weeks).

Blood samples (8-10ml for adults; 1-5ml for children) and blood culture bottles were collected from patients presenting to participating iHDSS clinics who met the case definition of a febrile illness. Specimens were labelled appropriately and linked to the HDSS Morbidity Case Forms for identification of clinical history. Samples were stored at 4°C and transported to the PNGIMR laboratories for further analysis.

Blood culture samples were analysed using standard procedures in the Bactec system. Serum was removed from blood samples and nucleic acids were extracted using the Qiagen DNeasy Blood and Tissue kit. Molecular analysis using real-time PCR was conducted for the febrile pathogens listed in Table 1.

Table 11-1. List of pathogens tested for by real-time PCR.

First-line Testing			
Febrile Illness	Dengue virus 1	Dengue virus 2	Dengue virus 3
	Dengue virus 4	Chikungunya virus	Ross River virus
	Salmonella Typhi	*Leptospira* spp.	
Enteric Illness	Rotavirus	Norovirus G1	Norovirus G1
	Adenovirus 40/41	*Shigella* spp.	*Salmonella* spp.
	Campylobacter spp.	*V. cholera* hylA	
Second-line Testing			
Febrile Illness	Japanese encephalitis virus	Murray Valley encephalitis virus	Barmah Forest virus
	Kunjin virus	*Rickettsia* spp.	*Orientiatsutsugamushi*
Enteric Illness	Sapovirus	Astrovirus	*V. cholera* CTX

11.3 RESULTS

11.3.1 Retrospective Testing of Stored Samples

Acute Watery Diarrhoea in Goroka

Analysis of the age distribution of infections between children aged <1 year (n = 125) and children aged 1–5 years (n = 74) showed no significant difference in the detection rate of pathogens between the two age groups (Fisher's exact test, data not shown). Young children were much more likely to be admitted to hospital with acute gastroenteritis, with 62.8% of patients aged <1 year and 88.4% aged <2 years. An enteric pathogen was detected in 69.8% (n = 138) of stool samples collected from children hospitalized with acute gastroenteritis. Shigella spp (26.6%, n = 53), rotavirus (25.6%, n = 51), and adenovirus 40/41 (11.6%, n = 23) were the enteric pathogens most commonly detected (Table 2).

Table 11-2. The frequency of pathogen detection in children (<5 years) hospitalized with acute gastroenteritis.

Characteristics	Total (n=199)
Tested positive for a pathogen	138 (69.8%)
Multiple pathogens detected	44 (22.1%)
Shigella sp.	53 (26.6%)
Rotavirus	51 (25.6%)
Adenovirus 40/41	23 (11.6%)
Enterotoxigenic*E. coli* (ETEC)	22 (11.1%)
Enteropathogenic*E. coli* (EPEC)	17 (8.5%)
Norovirus G2	12 (6.0%)
Campylobacter sp.	8 (4.0%)
Norovirus G1	7 (3.5%)
Sapovirus	4 (2.0%)
Salmonella sp.	2 (1.0%)
Vibrio cholera	0 (0%)
Astrovirus	0 (0%)
Co-infections*	
Shigella sp. and rotavirus	10 (5.0%)
Shigella sp. and ETEC	8 (4.0%)
Rotavirus and adenovirus 40/41	5 (2.5%)
Rotavirus and norovirus G1	3 (1.5%)
Norovirus G2 and EPEC	3 (1.5%)
Shigella sp. and EPEC	3 (1.5%)
Shigella sp. and adenovirus 40/41	3 (1.5%)
Shigella sp. and *Campylobacter* spp.	2 (1.0%)
Shigella sp. and norovirus G2	2 (1.0%)
Rotavirus and *Campylobacter* sp.	2 (1.0%)
Rotavirus and ETEC	2 (1.0%)

11.3.2 Evaluation of Rapid Diagnostics for Enteric Illnesses

The detection sensitivities of HNB and SYBR Green I were identical across all 3 LAMP assays used in this study. The colorimetric dyes detected <48 CFU, <9.6 CFU, and <3.2 CFU for the *Salmonella*, *Shigella*, and *V. cholerae* assays, respectively. Comparatively, the real-time PCR assays were between 1 and 2 logs more sensitive than the LAMP colorimetric assays, which are comparable to other studies that have directly compared real-time PCR and LAMP. However, bacteria are usually excreted in very high numbers in patients with enteric infections such as salmonellosis, shigellosis, and cholera, and therefore, the LAMP assay may have sufficient sensitivity for clinical use. The assays showed good repeatability with identical results recorded for duplicates and no discrepancies between the independent readers.

LAMP assays are particularly attractive for resource limited settings as they do not require costly equipment (compared to expensive thermocyclers needed for PCR and real-time PCR) and are highly specific and sensitive. We have shown that the application of colorimetric dyes, as indicators for a positive reaction, can improve the simplicity of the interpretation of results, without adversely impacting on sensitivity of the assay. Indeed, the sensitivity of the LAMP assay is such that it could be used for case-control studies to detect carriage as well as disease.

Respiratory Illness in Goroka

For analysis of the aetiology of ILI in Goroka, the participant samples were split into two groups for analysis: children <5 years of age (n=167) and all other patients >5 years of age (n=133). Among the 300 patients presenting with an influenza- like-illness, a viral respiratory pathogen was detected in 66.3% (n=199) of samples. HRV (17.0%, n=51), influenza A (16.7%, n=50), and influenza B (12.7%, n=38) were the viruses most commonly detected in the nasopharyngeal swabs (Table 3).

The rates of virus detection for most of the viruses included in this study were not significantly different between the two age groups analyzed (<5 and >5 years). However, influenza B (P=0.0081), HAdV (P=0.0001), and HRSV (P=0.0017) were all detected at significantly higher rates in patients <5 years of age with an influenza-like-illness (Table 3). There was also a significant difference in the two age groups for the detection of at least one viral pathogen in a patient (P=0.0001) and the detection of viral coinfections (P=0.0015).

Table 11-3. The frequency of viral detection in patients with influenza-like-illness.

Characteristics	Number of cases (%)			
		Age distribution of viruses		
	Total (n=300)	<5 yr (n=167)	> 5yr (n=133)	*p*value[a]
Tested positive for a virus	199 (66.3)	132 (79.0)	67 (50.4)	**0.0001**
Multiple viruses	30 (10.0)	25 (15.0)	5 (3.8)	**0.0015**
Influenza A	50 (16.7)	26 (15.6)	24 (18.0)	0.6405
Influenza B	38 (12.7)	29 (17.4)	9 (6.8)	**0.0081**
Rhinovirus	51 (17.0)	33 (19.8)	18 (13.5)	0.1667
Respiratory syncytial virus	26 (8.7)	22 (13.2)	4 (3.0)	**0.0017**
Adenovirus	20 (6.7)	19 (11.4)	1 (0.8)	**0.0001**
Parainfluenza virus 1	8 (2.7)	4 (2.4)	4 (3.0)	0.7363
Parainfluenza virus 2	4 (1.3)	4 (2.4)	0 (0)	0.1321
Parainfluenza virus 3	19 (6.3)	13 (7.8)	6 (4.5)	0.3408
Metapneumovirus	3 (1.0)	0 (0)	3 (2.3)	0.0860
Coronavirus 229E	2 (0.7)	0 (0)	2 (1.5)	0.1957
Coronavirus OC43	8 (2.7)	5 (3.0)	3 (2.3)	0.7363
Coronavirus NL63	2 (0.7)	0 (0)	2 (1.5)	0.1957
Coronavirus HKU1	2 (0.7)	2 (1.2)	0 (0)	0.5048

[a]*p* value - Fisher's Exact Test (significant values in bold)

Febrile Illness in Wipim, Western Province

All of the clinical samples from Wipim were tested for regionally important arboviruses and rickettsials to detect the aetiological agents of fever in the area. Dengue virus 1 (DENV-1) was detected in 11.0% (n=15) of the samples. Malaria was detected in three patients by both light microscopy and PCR. No other dengue type and no other pathogens of interest were detected in any of the samples.

There was no significant difference between the mean age of dengue infected patients (12.5 years) and non-infected patients (19.0 years). Likewise, there was no statistical significance in the sex distribution of dengue infected patients. However, we found that a significant proportion (86.7%; Fisher's exact test, p=0.011) of dengue patients were residents in Wipim, whereas Wipim residents only constituted 54.4% of all screened patients. This result suggests that there was an outbreak of DENV-1 occurring at the time of sampling with a focus of infection in the village of Wipim.

Febrile Illness Outbreak, Vanimo, Sandaun Province

CHIKV was detected in 36% of samples screened during the outbreak in Vanimo. Subsequent sequence analysis of the E1 gene showed that the outbreak was caused by CHIKV from the ECSA genotype (Figure 1). All 3 CHIKV strains sequenced had the E1:A226V mutation which is associated with greater transmissibility of the virus in *Aedes albopictus* mosquitoes.

This outbreak was the first time that CHIKV had ever been detected in Papua New Guinea. The outbreak went on to spread throughout the country, causing tens of thousands of cases. Through the PiH program we were able to rapidly detect the virus that was causing the outbreak (within 2 days of receiving samples) and support the NDoH with the laboratory testing to confirm the spread of the outbreak to 11 other provinces of PNG.

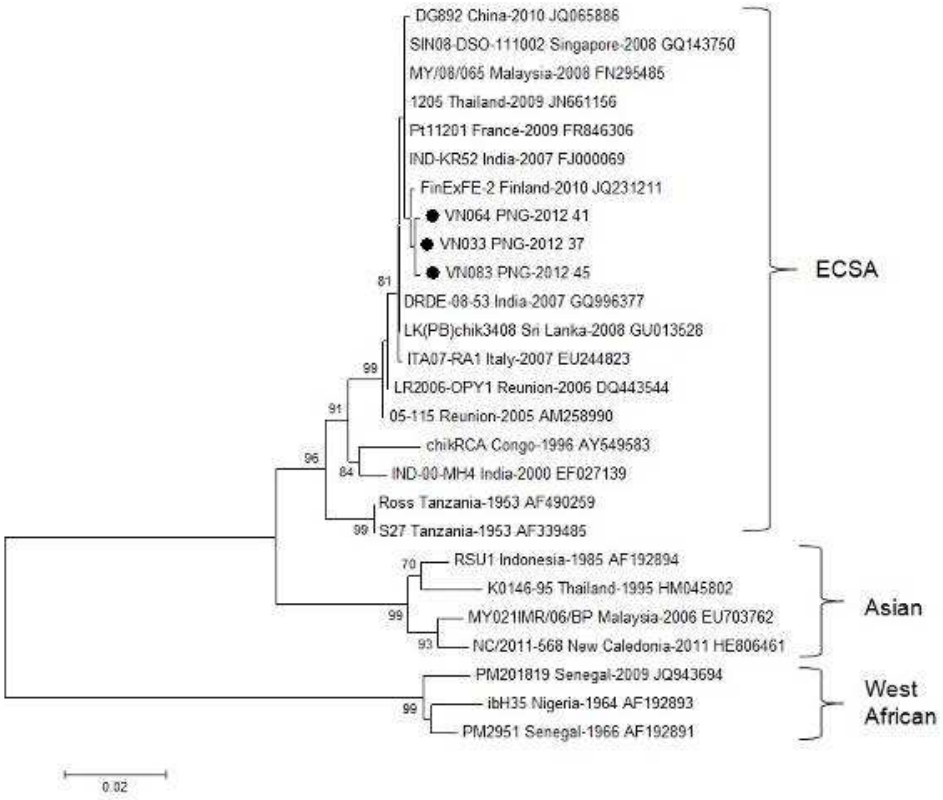

Figure 11-1. Phylogenetic analysis of the E1 gene from Papua New Guinean Chikungunya virus strain.

11.3.3 Sentinel Surveillance Samples Collected

Samples were successfully collected from all four iHDSS sites. The number of samples collected from each site together with time period are shown in the table below (Table 4)

Table 11-4. Prospective samples collected from iHDSS sites for febrile and diarrhoeal disease surveillance.

Location	Collection Period	Samples Collected		Total Samples
		Stool	Blood	
Asaro	May 2012 to Sep 2014	22	110	132
Hides	Aug-Nov 2013 and Aug 2014	33	32	65
Hiri	Aug 2013 to Oct 2014	53	105	158
Karkar Island	Nov 2013 to Nov 2014	10	146	156

Many obstacles were faced by collectors on the ground during the study period. These issues will be addressed in the discussion section.

11.3.4 Febrile Illness Results

Asaro

Eighteen Chikungunya and 1 dengue case were observed over the study period. The one dengue case was determined to be serotype 2. The Chikungunya cases occurred during the nation-wide outbreak period of Nov 2012 and Aug 2013, making up 41% (18/44) of the febrile cases reported, Figure 2. No malarial infection data were available.

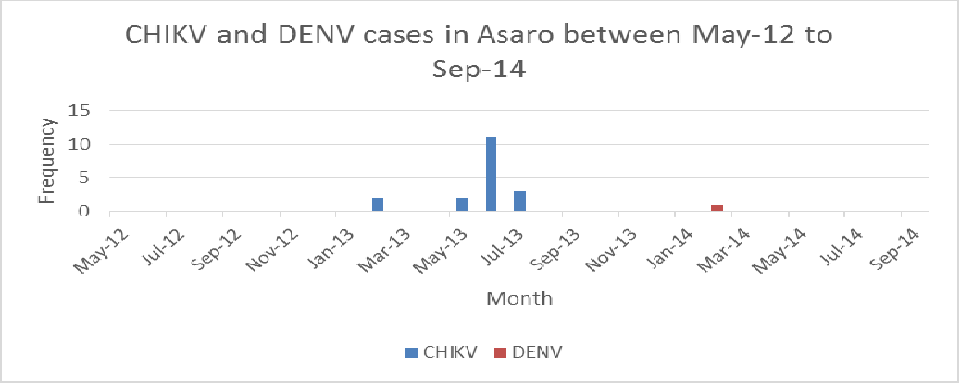

Figure 11-2. CHIKV and DENV cases in Asaro between May-12 and Sep-14.

Hiri

One dengue case (serotype 2) (Apr-14) and one Barmah Forest virus case (also Apr-14) were detected in Hiri during the study period. No malarial infection data were available.

Hides

Only one dengue case (serotype 2) was detected in Hides (Aug-14) during the study period. No malarial infection data were available.

Karkar Island

One case of Leptospirosis was picked up on Karkar Island during the study period. 47 (32.2%) patients were also diagnosed with malaria by RDT (Figure 3). The observed Leptospira spp. infection was a co-infection with malaria.

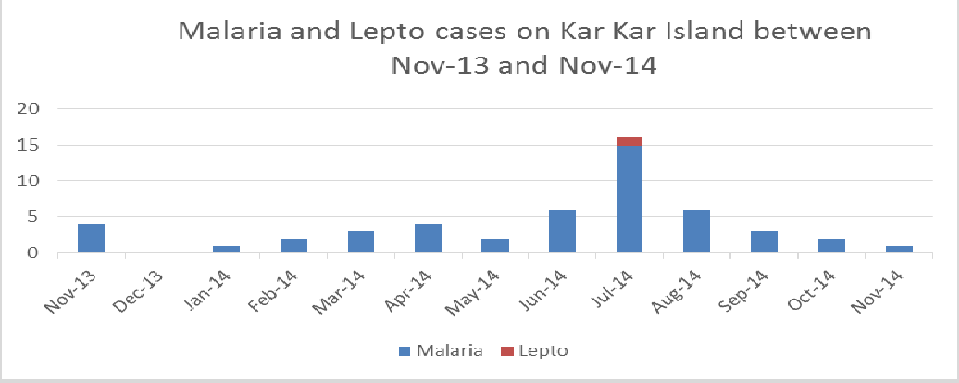

Figure 11-3. Malaria and Leptospirosis cases on Karkar Island between Nov-13 and Nov-14.

11.3.5 Enteric Illness Results

Asaro

Stool samples from Asaro were only collected between Feb-2014 and Aug-2014. This is as a result of a lack of toilet facilities for patients to use for self-collection of stool samples. A toilet was built during the early part of the project, but due to plumbing issues and connection to central water pipelines, it was not ready for use by patients until Feb-2014. As a result, only 22 stool samples were collected from Asaro during the study period.

Results of testing showed that *Shigella* spp. had the highest incidence (9/22, 40.9%), followed by *Campylobacter* spp. (6/22, 27.3%), Figure 4. No Norovirus G1, *Salmonella enterica* serovar Typhi or *Vibrio cholerae* was observed in the cohort.

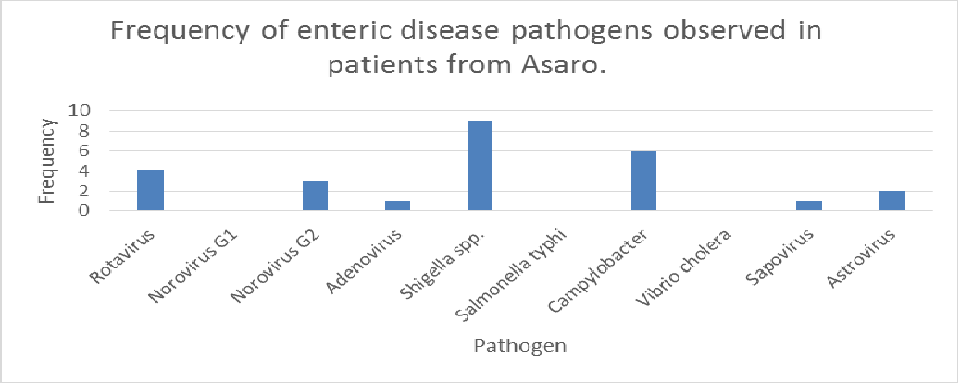

Figure 11-4. Frequency of enteric disease pathogens observed in patients from Asaro.

Of the 22 samples, 5 (22.7%) were found to have co-infections of between 2-4 pathogens as visually presented in Figure 5 below. It is interesting to note that astrovirus was only detected as co-infections and 4 out of 5 of the co-infections involved *Shigella* spp.

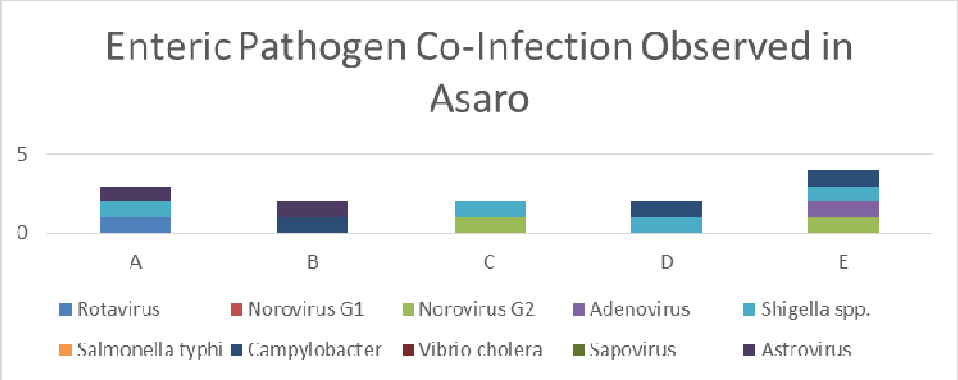

Figure 11-5. Enteric pathogen co-infection observed in Asaro.

Hides

The collection in Hides occurred in September to November 2013 (Figure 6). However it was stopped after conflict arose between at least two rival factions. Twenty-one stool and 1 blood samples were collected during this period. An *adhoc* collection was organised in August 2014, i.e., a 2 week trip where an additional 31 blood and 12 stool samples were collected. However, mid-trip another incident occurred where casualties to local residents threatened spill-over violence to Sentinel Surveillance staff. A second trip was later organised in Oct/Nov-2014 but Sentinel Surveillance did not participate as the study was winding down and no staff were available.

Results from testing continue to show that *Campylobacter* spp. is still the main cause of diarrhoeal illness in Hides (21/33, 63.6%) (Figure 6). This is of no surprise as results in past reports have shown similar high rates of *Campylobacter* spp. No *S. enterica* serovar Typhi, *Vibrio cholera* and Astrovirus were detected in samples from Hides.

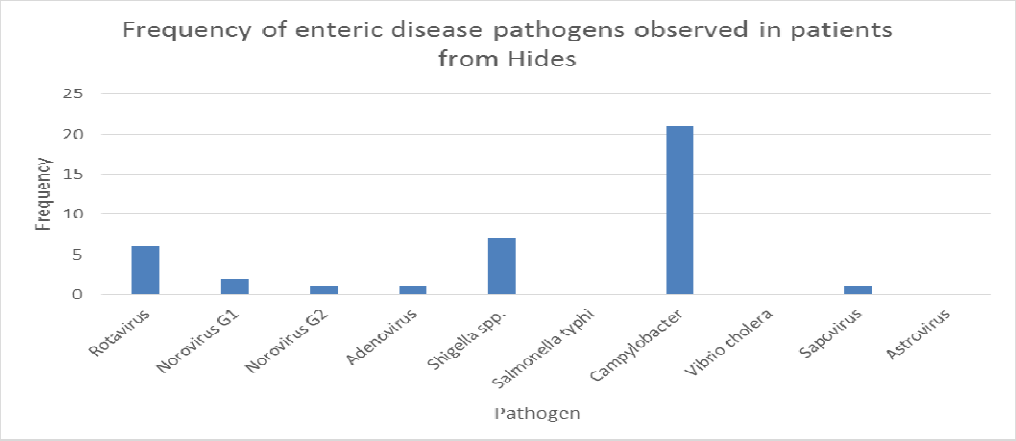

Figure 11-6. Frequency of enteric disease pathogens observed in patients from Hides.

There were 10 co-infections observed in Hides, making up 30.3% of the cohort (Figure 7). Of the co-infections, 90% (9/10) had *Campylobacter* spp. present.

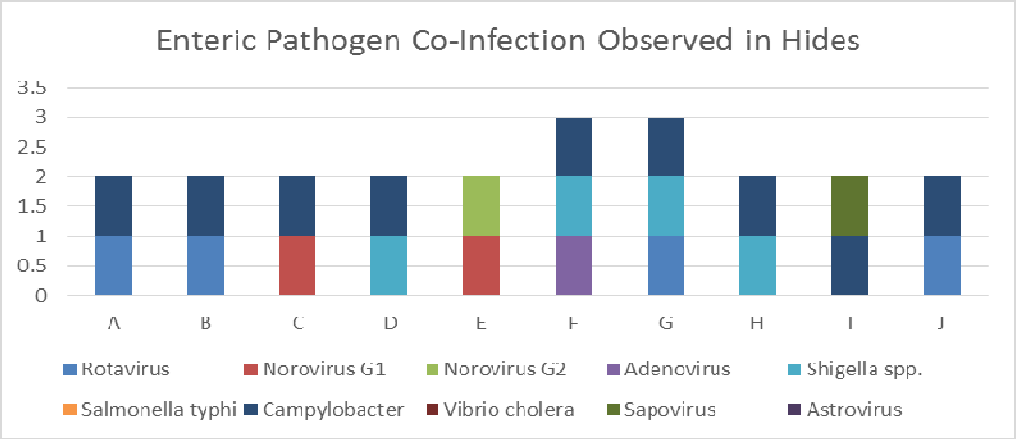

Figure 11-7. Enteric pathogen co-infection observed in Hides.

Hiri

A total of 53 stool samples were collected from Hiri between Aug-13 to Oct-14. However no stool samples were collected in Jan-14, Sep-14 and Oct-14. Results from screening the samples for both first- and second-line pathogens are illustrated in Figure 8 below.

Pathogens in samples from both single-infection and multi-infections are illustrated in Figure 8.

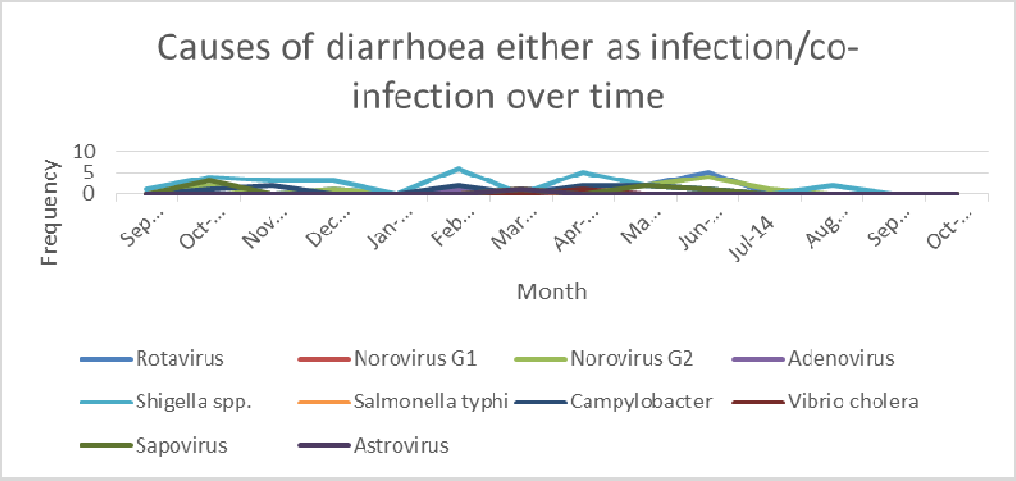

Figure 11-8. Causes of diarrhoea either as infection/co-infection over time.

Two notable diarrhoeal disease trends were observed, where (i) bacterial pathogens *Shigella* spp. and *Campylobacter* spp. were highest between Oct-13 and Apr-14, while (ii) viral pathogens (rotavirus and norovirus G2) were at their highest mid-2014.

Sixteen (30.2%) co-infections were observed in Hiri, Figure 9. The most common pathogens observed in the co-infection cases were *Shigella* spp. (9/16, 56.3%), Norovirus G2 (9/16, 56.3%) and *Campylobacter* spp. (8/16, 43.8%).

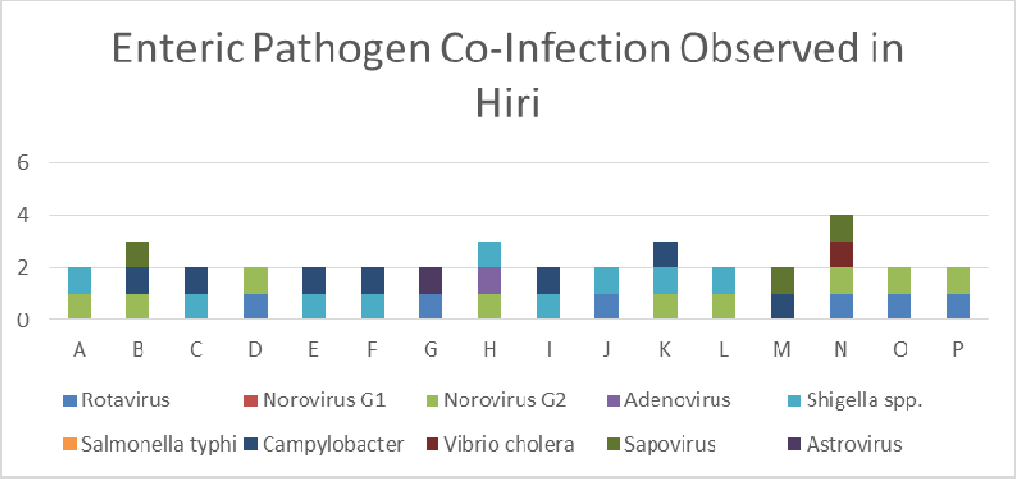

Figure 11-9. Enteric pathogen co-infection observed in Hiri. Individual patients are differentiated as alphabets.

Karkar Island

Only 10 stool samples were collected from Karkar Island. Results of testing the samples are shown in Table 10, where patients are identified as A-J. No pathogens were detected in two of the samples. Rotavirus had the highest prevalence (4/10), and Adenovirus 40/41was observed in three of the rotavirus infections.

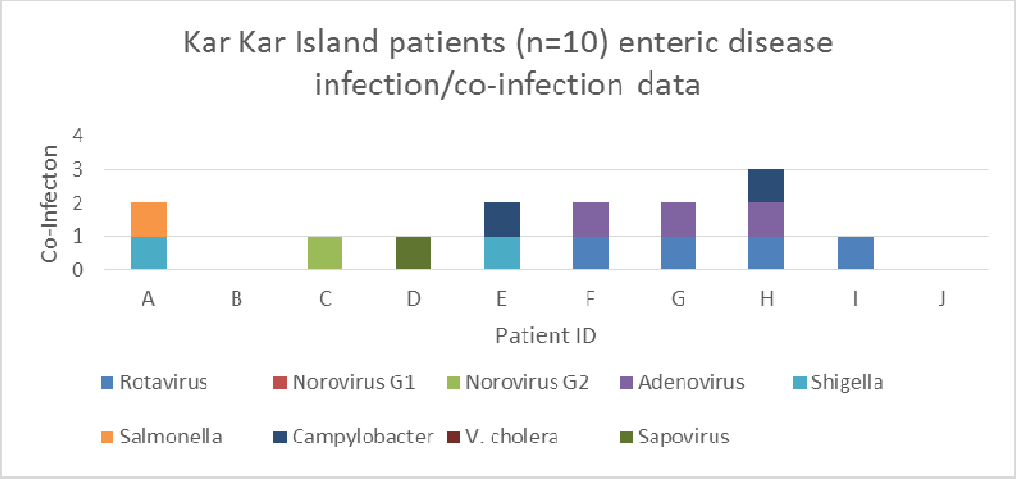

Figure 11-10. Karkar Island patients (n=10) enteric disease infection/co=infection data. Individual patients are differentiated as alphabets.

11.4 DISCUSSION

11.4.1 Role of surveillance

Disease surveillance is a crucial activity in any health system, in order to provide information for action. However the surveillance on a myriad of diseases afflicting Papua New Guineans is still lacking and does not provide a proper understanding of which specific infectious agents are the greatest burden on health. As demonstrated in this study, the diseases afflicting Papua New Guineans vary from site to site, presumably influenced by climate, geography, security, economy and health education. Some examples of data usage would be (i) to recognise disease trends to allow for appropriate policy making and preparation to meet specific disease peaks, (ii) identification of outbreaks that would usually go unnoticed, and (iii) formulation and assessment of measures to reduce burden in the community.

The data generated has provided significant insight and generated a number of observations and recommendations:

1 – Dengue is not as big a problem in PNG as was initially feared. To further reinforce this observation, no record of haemorrhagic dengue fever has been observed in PNG the past 20 years (except for 2 cases in Vanimo, 2012). The reasons why dengue is not a major health concern is discussed in subsequent sections.

2 – Even though major advances were made to reduce incidence of malaria in PNG, it is still the major cause of febrile illness in some areas of PNG; however, not in PNG LNG impact areas, i.e., Hides and Hiri. Malaria is a significant issue in Karkar.

3 – The introduction of diseases from outside of PNG is a real threat that has until recently not been fully appreciated. The recent Chikungunya, cholera and measles outbreaks are reminders of this threat. Epidemics of exotic diseases in other global regions (e.g. Ebola in western Africa) are a reminder of the need to maintain vigilance, and to have adequate surveillance systems in place and further highlights the need to be vigilant. The introduction of a highly infectious pathogeninto a nation with a health system that is facing multitudes of challengescould have very devastating results. PNG has so far been fortunate that the recent outbreaks that have made into the country have died out over a period of time naturally and not circulated further.

4 – The influence of economic/cultural activities can have a major health impact and thus influence the type of diseases circulating in communities. This is clearly observed in Hides, where the main cause of diarrhoeal illness is *Campylobacter* spp. This may be attributed to either an increase in chicken farming, or the practise of shared sleeping space with livestock due to poor security. Due to lack of data collected over a sustained period of time, EDDU cannot determine if external factors are influencing rate of infection.

5 – Rotavirus remains a significant cause of diarrhoeal illness at all four sites. This may provide further support for the need to investigate the feasibility of adding the rotavirus vaccine to the national vaccination schedule.

6 – Detection of "novel" diseases from the surveillance conducted further reinforces the importance of making such samples available. The detection of *Leptospira* spp., and Barmah Forest virus demonstrates that little is currently known of the disease ecology of PNG. There has been much speculation about the diseases "discovered" as existing here, but no human cases were reported until this study.

11.4.2 Low detection of causes of non-malarial febrile illness

It was surprising that no other causes of febrile illness were found in the samples collected. Questions arising with regards to sensitivity of the assays used especially with the dengue RT-PCR used were unfounded as assays used in the lab for testing have been tested by External Quality Assurance Panels (EQAP) organised by WHO and results attained by the lab has always been 100% for pathogens tested. Similar stringent standards are maintained for pathogens not tested on WHO EQAP programmes.

So the question that is still unanswered is, what is causing febrile illness in PNG?

In some locations in PNG, malaria is an important cause of febrile cases in PNG; however recent Global Fund prevalence studies in PNG (conducted by PNGIMR) found that the rate of RDT+/laboratory confirmed malaria was <2%. Nevertheless location and setting matters for malaria and significant variability is the rule rather than the exception. The unexplained cases could be a result of various possibilities. Other studies (PNG and abroad) similarly found high numbers of undiagnosed febrile cases(24). EDDU did expect to diagnose more febrile cases then we were able to with the prospective samples, however the rate of undiagnosed cases is still no surprise.

Most febrile pathogens are unlikely to be detected. One potential strategy would be the collection of a convalescent serum from each patient and watching for antibody titre increase to specific pathogens. Unfortunately this is not currently possible with the poor retention of patients for follow-ups in PNG. The problem of cross-reacting antibodies for similar pathogens would require much more in-depth and lengthier studies.

11.4.3 Vector competence influence on dengue transmission

Vector competence and efficacy in transmitting a pathogen to humans play a major role in diseases transmission. The last few decades have seen the introduction of *Aedes albopictus* into many new areas (25), with increasing density in some areas alongside the more traditional dengue vector, *Aedes aegypti* (26). The spread of *A. albopictus* have been linked to climate change; however, little is known on the environmental factors encouraging its spread (27). Dengue is well characterized as an urban disease, where many outbreaks in other parts of the world occur in "urbanized" communities where people live in extremely close proximity with each other. *Aedes albopictus* is believed to be a biologically competent vector for dengue, however its transmission efficacy has not been well-determined and suspected to be poor (26, 28). This could explain why there is little dengue reported in the locations chosen as sentinel sites.

This theory was further reinforced with the recent Chikungunya outbreak that started in Vanimo, Sandaun Province in 2013. EEDU together with the Entomology team of Vector-Borne Disease Unit, were able to provide field support to the NDoH early in the outbreak. Mosquito trapping early in the outbreak in Vanimo garnered mostly *A. albopictus* and no *A. aegypti* (13).

11.4.4 Diagnosis of dengue by RDT

There have been many discussions in the literature with regards on the over-reliance of DENV RDT only for diagnosis of dengue infection. The main argument is that RDTs have a relatively high percentage of misdiagnosis due to lack of sensitivity (29). Other more sensitive and accurate methods such as RT-PCR are available, and thus why the effort made to implement the assay at PNGIMR to provide additional diagnostic options in-country. There are now molecular assays available that can identify dengue serotypes in a single step in samples from suspected dengue patients (30, 31).

Recent studies following febrile outbreaks in the south-Pacific show possible evidence of cross-reactivity between DENV antigen RDT and *Leptospira* spp. This further confounds investigations into febrile aetiologies in the region where *Leptospira* spp. and DENV are endemic (pers. comm. with Dupont-Rouzeyrol, Pasteur Institute, New Caledonia).

11.4.5 Outbreak response

The results observed from the surveillance in Asaro were useful for determining Chikungunya prevalence post-outbreak (after mid-2013). Unfortunately, no data were available during the outbreak period at the other locations. No Chikungunya were detected in febrile patients for 12 months after the outbreak was deemed officially over, demonstrating that the virus may not be endemic in PNG as feared.

Not only was EDDU successful in responding to the CHIKV outbreak, but work subsequent to the CHIKV outbreak involved responding to other outbreaks both intra- and inter-province. Some of the outbreaks EDDU were able to respond to include an outbreak of shigellosis in Morobe Province (2013) (32) and providing advice and scientific support during the nation-wide measles outbreak of 2014.

11.4.6 Overcoming cultural taboos and other sociological influences on study progression

One of the major problems faced in sample collection was the cultural taboo of giving away bodily waste. This is not a new concept and is well in-grained in many Pacific cultures, especially Melanesian culture. The belief is that bodily fluids (blood and stool) can be used in the acts of witchcraft and other spiritual practices. There is little that can be done to combat this belief system other than continued community education by the project staff of the importance of the requested bodily fluids for pathogen testing.

The compensation culture among Papua New Guineans is also a major factor where participants expect something in "payment" for their contribution. This problem was further exacerbated with the perceived link between study staff and project funders, i.e., PNGIMR staff are not considered to be PNG government employees. The ethical standpoint taken by the study is that payment in whatever form to the community should be discouraged, whether it be in the form of cash or gifts.

Spillover violence from conflicts within the community and unhappiness towards the government (PNGIMR is a government statutory board) are real threats that increase the risk towards the study staff. This was observed in sample collection efforts in Hides where PNGIMR staff are embedded in the community health centre and vulnerable to threats of violence.

The shift in PNG from *A. aegypti* to *A. albopictus* was never recorded in the past and thus the period of time it was believed to have occurred is unknown. The latest sero-survey of dengue infections in acute febrile patients in Madang, demonstrated 8% of cases were positive for dengue by serology. However, unpublished reports had surfaced recently putting into question the accuracy of dengue serology (see above) (24).

11.4.7 Poor infrastructure at selected sites

Infrastructure at selected sites was poor, with all study sites not having any toilet facilities, except for Karkar Island. The lack of other infrastructure such as electricity (example, Karkar Island only had electricity during the day time) and water contributed heavily to the significant delays in sample collection.

11.4.8 Capacity building and expenditure priorities

This study was successful in building and strengthening capacity at PNGIMR, benefitting PNG:

1) Outbreak response and prompt diagnosis of large number of samples coming in from outbreak locations.
2) Trained staff to handle, store and analyse outbreak samples.

3) Expand capacity to detect pathogens of various types (bacterial, viral, protozoan, helminthic) with high sensitivity and specificity, especially those that have been poorly understood and characterized.
4) Recognised as a centre of excellence in diagnostics and research in emerging infectious diseases by neighbouring countries, with robust assays and trained staff.

The move to molecular testing was justified as many diagnostic labs worldwide are now moving towards more sensitive methods of pathogen testing. Real-time PCR though new to PNG, is considered the "bread and butter" of many labs, alongside newer technologies such as the Maldi-Tof, Gene-Xpert and Next-Gen sequencing.

Not only was physical capacity built up by the project, but Papua New Guinean scientists and clinical staff were heavily involved in the study from the start, thus ensuring that the infrastructure available is fully utilised. To continue maintaining the capacity now available at the PNGIMR, similar, if not, higher level of research and surveillance work needs to be performed.

Much of the funding provided for the Sentinel Surveillance sub-study was in developing new assays and introducing new research platforms. EDDU was able to fully utilise the newly developed technologies and national staff benefitted from the training and experience received.

11.4.9 Further work leading on from Sentinel Surveillance

Further work is currently being planned that follows from the capacity built up from the sub-study. The importance of surveillance have been showcased, demonstrating the useful data that can be derived from continued surveillance of diseases occurring in communities with highly sensitive state-of-the-art detection methods.

- Arboviral surveillance is currently being discussed and potentially implemented in late-2015 to 2016 as part of a regional effort to monitor arboviral spread in the South-Pacific region. This initiative includes various research institutes in the region and the governments of most, if not all South-Pacific nations. This is especially timely with the recent CHIKV outbreaks in the South-Pacific and the more recent spread of Zika virus.
- Diseases that originate from animals but can be highly pathogenic to humans such as avian influenza, Campylobacter etc. are currently part of a small surveillance programme ongoing with the National Agriculture and Quarantine Inspection Agency.
- Continued PNGIMR involvement in the WHO influenza and rotavirus surveillance programmes. We are currently in discussions with the NDoH and relevant public health assessments (PHAs) to strengthen these programmes in 2016. Discussions have started on the use of the rotavirus surveillance data to determine the need for a rotavirus vaccine in PNG.
- Availability of the various detection assays have strengthened PNGIMR's role in the national health system as a centre of innovation and excellence. We are able to provide prompt and immediate diagnostics of "exotic" diseases. Plans are already in place to further expand into other diseases rarely diagnosed but with high morbidity and mortality rates, such as hantavirus, henipavirus, Coxiella burnettii, etc.

11.5 CONCLUSIONS

PNG will continue to be threatened by outbreaks of various pathogens that will not only affect humans directly, but also animals and plants. These will indirectly impact on human health and economics. The threat of a Zika virus outbreak looms over PNG. Neighbouring countries with similar health challenges and worse in some cases, are currently dealing with Zika virus infections. This highlights the need of long-term surveillance nation- and region-wide. Surveillance programmes are time and effort intensive in addition to being financially costly. The risk of disease and outbreaks are not a matter of whether they will happen but a matter of when.

The Sentinel SS has revealed interesting patterns of disease etiologies across iHDSS locations. Results indicate that much greater insight into potential interventions can be gained when an accurate understanding of the true spectrum of infectious agents is understood.

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APPENDIX I - ASSAYS DEVELOPED AND READY FOR USE FOR DIAGNOSTIC AND RESEARCH PURPOSES IN EEDU

Diarrhoeal Disease	Pathogen
Cholera	*Vibrio cholera*
Shigellosis	*Shigella* spp.
Salmonellosis	*Salmonella* spp.
Campylobacteriosis	*Campylobacter* spp.
Traveller's diarrhoea	Pathogenic *E. coli* (ETEC/EPEC)
Viral diarrhoea	Rotavirus
	Adenovirus
	Norovirus (G1 & G2)
	Sapovirus
	Astrovirus
Enteric parasites	Hookworm (*Necator americanus*)
	Roundworm (*Ascaris lumbricoides*)
	Strongyloides stercoralis
	Giardia spp.
	Cryptosporidium spp.

Febrile Disease	Pathogen
Barmah Forest fever	Barmah Forest virus
Chikungunya fever	Chikungunya virus
Dengue fever	Dengue viruses (DENV 1-4)
Japanese encephalitis	Japanese encephalitis virus
Rickettsiosis/Typhus	*Rickettsia* spp.
Scrub typhus	*Orientia tsutsugamushi*
Typhoid fever	*Salmonella enterica* Typhi
Murray Valley encephalitis	Murray Valley encephalitis virus
Zika fever	Zika virus
Haemorrhagic fever	Hantavirus
Ross River fever	Ross River virus
Weil's diseases	*Leptospira* spp.

Respiratory Disease	Pathogen
Human influenza	Influenza virus A and B (Subtyping)
Avian influenza	Influenza virus A
Respiratory Disease	MERS-CoV
	Coronavirus
	Respiratory syncytial virus
	Metapneumovirus
	Parainfluenza 1-3
	Adenovirus
	Rhinovirus
Pneumonia	*Streptococcus pneumonia*
	Haemophilus influenza B

Other Diseases	Pathogen
Measles	Measles virus
Mumps	Mumps virus
Rubella	Rubella virus
Chicken pox	Varicella zoster virus
Herpes	Herpes virus 1 and 2
Diphtheria	*Corynebacterium diphtheriae*
Whooping cough	*Bordetella pertussis*
Hand, foot and mouth disease	Enterovirus 71

APPENDIX II – PEER-REVIEWED PUBLICATIONS OF DATA GENERATED DIRECTLY FROM THE STUDY

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12.0MATERNAL AND NEWBORN HEALTH

Maternal And Newborn Health In 3 Sites In PNG:
A Quantitative And Qualitative Survey
(A Sub-Study Of The Partnership In Health Project)

Principal Investigator

Lisa Vallely Senior Research Fellow, Maternal and Child Health, Papua New Guinea Institute of Medical Research (PNG IMR), Alotau Branch, Milne Bay Province, PNG.

Co-investigators

Primrose Homiehombo Research Nurse, Maternal and Child health, PNG IMR, Goroka, EHP, PNG

A/Professor Andrea WhittakerARC Future Fellow, Anthropology, School of Social Sciences, Monash University, Melbourne, Australia

Professor Caroline Homer Professor of Midwifery, University of Technology Sydney, Australia

Dr Suparat Phuanukoonnon Partnerships in Health Project Coordinator, PNGIMR, Goroka, EHP, PNG

Professor Glen Mola Professor of Obstetrics and Gynecology, University of PNG, Port Moresby, NCD PNG

Dr Lahui Geita Technical Adviser Maternal Health, National Department of Health, Port Moresby, NCD, PNG

Professor Peter Siba Director PNG IMR, Goroka, EHP, PNG

ABSTRACT

Background Papua New Guinea (PNG) has one of the highest maternal mortality ratios in the World with an estimated 584 maternal deaths per 100,000 live births. While 60-78% of women in PNG receive antenatal care at least once in their pregnancy, only 37% of births are supervised by a skilled birth attendant. Unsupervised, non-health facility birth is a contributory factor towards poor health outcome of both the mother and her infant. The overall aim of the Maternal and Infant Health survey was to estimate the prevalence and causes of maternal morbidity and the uptake of maternal and infant health services; and to investigate women's perceptions and experiences of pregnancy and childbirth in three of the four Partnership in Health demographic sites. Only three sites were ultimately accessed due to funding and security issues.

Findings 482 women were surveyed about their most recent pregnancy in Hiri, Karkar and Asaro. Almost three-quarters (71%) of women presented for ante natal care in their second trimester and 69% of all women attended antenatal care for the recommended minimum of four visits. Overall, the antenatal care received did not meet the minimum standard requirements, as outlined by the PNG National Department of Health guidelines for antenatal care. Opportunities to screen for risk factors in pregnancy were missed, including the opportunity to monitor for anaemia, test for HIV and syphilis and provide preventative health care including provision of mosquito nets and tetanus toxoid immunization. In total, 64% of all women surveyed gave birth at a health facility, but only 89% of these were attended by a health care worker; 8% gave birth assisted by a relative or friend and 3% gave birth alone at the health facility. One third of all women mentioned knowing danger signs in pregnancy with fever, swelling of the lower limbs and bleeding the most frequently mention problems. Almost two-thirds (60%) of women knew danger signs in the newborn, with fever being the most commonly mentioned danger sign followed by infant crying too much. The majority of neonates (72%) were breast fed either immediately or within the first two hours following birth, a practice important for a safer outcome for the neonate, especially given the high proportion of low birth weight infants.

ABBREVIATIONS

ANC	Antenatal care
LBW	Low birth weight
MCH	Maternal and child health
MMR	Maternal mortality ratio
MDG	Millennium development goal
NMR	Neonatal mortality rate
PiH	Partnership in Health
TBA	Traditional birth attendant
VBA	Village birth attendant

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BACKGROUND

Maternal health refers specifically to the health of women surrounding pregnancy and childbirth, that is the antenatal, intrapartum (labour and childbirth)and postnatal period. Provision of antenatal care and births attended by skilled birth attendants impacts the survival of both the mother and her infant[1].

Despite a global decline in the maternal morality ratio (MMR), every year an estimated 292,982 women die as a result of pregnancy and childbirth [2] - 99% of these deaths occur in developing countries, the majority in rural areas with the poorest and most remote areas bearing the burden. An estimated 88-98% of all maternal deaths could be avoided [3] with many deaths occurring due to poor service provision and lack of access to and use of available services. At least half of all maternal deaths (50%-70%) occur in the postpartum period[19] - 45% within the first 24 hours following birth[3]. Postpartum haemorrhage is the leading cause of maternal mortality[3].

A maternal death is frequently accompanied by either a stillbirth or early neonatal death. Every year an estimated 2.6 million infants are stillborn[4]; nearly one million of these stillbirths occur during labour [5]. Four million newborn babies die – 3million within the 1st week of life; 1million within the first 24hours after birth[6,7]. Preterm birth[20] and low birth weight (LBW[21]) are important risk factors for neonatal mortality. The majority of the 13million preterm births that take place every year occur

[19]The postpartum period: the period of time from approximately one hour after delivery of the baby up to 42 days after the birth of the infant.
[20] Pre-term delivery - delivery before 37 completed weeks of pregnancy
[21] Birth weight less than 2.5 kg at delivery

in low-middle income countries; 16% of infants in the developing world have LBW. LBW infants are 20 times more likely to die than heavier babies with 60-80% of all neonatal deaths occurring in LBW infants.

Factors associated with maternal death are well documented and there is widespread agreement of the clinical interventions that could avert many maternal and perinatal deaths. If the MMR in developing countries is to be reduced there is a need for increased attention to improved health care for women, including provision of high quality care during pregnancy and childbirth, including emergency obstetric care[8]. Of particular importance is the need to ensure that all births are attended by skilled health professionals working within a functional health system; timely management and treatment can make the difference between life and death. In many developing countries, the health system is weak and cannot adequately respond to the health needs of mother and neonate due constraints including inadequate skilled attendants, lack of equipment, medications and supplies and a poor referral system.

Poor women in remote areas are the least likely to receive adequate health care during pregnancy and childbirth. These women are more likely to give birth at home, often in rural settings, and are largely assisted by a family member or a traditional birth attendant (TBA).

12.1 MATERNAL AND INFANT HEALTH IN PNG

The social and geographical diversity, together with poor infrastructure can mean substantial barriers and constraints, especially in terms of provision of health care for many people in Papua New Guinea (PNG). Accurate estimations of morbidity and mortality in PNG are hampered by insufficient surveillance and reporting systems [9]. The overall health status of Papua New Guinean people is reported to be the lowest in the Pacific region.

Health indicators for maternal and neonatal health in PNG are poor. Between 60-78% of women receive any antenatal care (ANC) from a health professional [10,11] with just over half of all women receiving the recommended four antenatal visits [12]. Tetanus Toxoid coverage for pregnant women is 69% [10], a reflection of poor health service provision[9].

PNG has the second highest MMR in the Asia-Pacific region and one of the highest in the world with an estimated 584 deaths per 100,000 live-births [2], a figure attributable to a deterioration in rural health services coupled with poor uptake of available health services[9]. Only 37% of births are attended by a health professional [13]; 7% of women giving birth at home are attended by a relative; 4% by a village birth attendant and 7% report giving birth alone. Complications during childbirth, including prolonged labour, excessive bleeding and convulsions are reported by many women[10]. Unsupervised, non-health facility births is a certain contributorto the poor health outcomesfor both the mother and her infant [14].

While improvements have been seen in the Under-5 mortality rates in PNG, the neonatal mortality rate (NMR) remains relatively unchanged and high at 29 per 1,000 live births [10]. In rural facilities, neonatal sepsis is one of the leading causes for admission accounting for 3.3% of all admissions; it is also one of the leading causes of mortality, accounting for 7.8% of all deaths in rural facilities in 2008 [12]. In PNG, 10% of infants are of low birth weight, a significant risk factor for poor neonatal outcome, including mortality.

PNG is a signatory to the Millennium Development Goals (MDGs). While indicators towards MDG4 (reduce child mortality) are slowly improving, MDG5 (improve maternal health) is lagging behind and PNGs commitment to achieving progress towards MDG5 is clearly under threat [9]. There is an urgent need to focus and prioritise maternal and child health (MCH) in PNG to work towards achieving the MDGs. While the wider issue of health systems is addressed, there is a need to address what can be done for women and their infants at the local level. Considering the geographical and cultural diversity in PNG and access, uptake and availability of professional skilled health care during pregnancy, childbirth and the postpartum period, research that highlights specific constraints and problems women experience could add valuable information to this much needed area of health.

One of the overarching aims of the PNG LNG Partnership in Health Project (PiHP) is to monitor the impact of the PNG LNG project on the health of the population in four sites – the two impact and two control communities. The PiHP has provided an ideal platform for further research allowing the opportunity to gain specific information relating to maternal and infant health in each of the four study sites. The opportunity has allowed the research team to obtain information relating to barriers in accessing maternal and child health services and provide insight into cultural beliefs, practices and experiences surrounding pregnancy, childbirth and the postpartum period.

As a sub-study of this wider PiHP, the overall aim of the Maternal and Infant Health survey is to estimate the prevalence and causes of maternal morbidity; the uptake of maternal and infant health services; and to investigate women's perceptions and experiences of pregnancy and childbirth at three sites in Papua New Guinea (PNG).The primary and secondary objectives of this study are detailed below.

12.1.1 Primary Objectives

1. To estimate the prevalence of maternal morbidity (adverse health outcomes during pregnancy, labour, birth and the postnatal period);
2. To estimate the proportion of women who have births supervised by a skilled birth attendant.

12.1.2 Secondary Objectives

1. To identify women's experiences of antenatal care and their adherence to the advice and treatment provided;
2. To identify where women give birth and the decision-making processes relating to place of birth;
3. To explore women's experiences, perceptions and beliefs surrounding place of birth;
4. To identify factors that hinder women's access to health care services during pregnancy, labour and birth, and the postnatal period;
5. To identify women's experience and knowledge regarding care of the newborn.

12.2 METHODOLOGY

A sampling framework was developed following the completion of the demographic and health survey in three of the four surveillance sites (Central Province, Eastern Highlands province and Madang Province). This cross sectional survey was conducted among 482 women aged 15-44 years in the three demographic surveillance sites: Hiri district (Central), Karkar, (Madang) and Asaro (Eastern Highlands). The survey took place following the baseline demographic surveillance, and subsequent follow-up survey phase. The survey was conducted among women who had given birth within the time frame of the PiHP (2010 to 2014) and who were registered in the census with individual identity numbers within the PiHP demographic surveillance database. In order to reduce the risk of recall bias, we initially identified women based on their report of being pregnant at the most recent demographic update, that is, those reporting being pregnant during late 2012 and early 2013. In order to reach our sample size it was necessary to extend the sample size to women who had given birth during 2011 and 2010, but who still met the criteria for having individual identity numbers within the PiHP demographic surveillance database.

Women selected for inclusion were visited in the community by a trained member of the IMR research team who gained consent following completion of study-specific informed consent procedures. Participants were interviewed in *tok pisin* using a piloted, study-specific semi-structured questionnaire. Interviews took place in the women's own home, unless they requested for it to be undertaken elsewhere. Each interview took between 20-40 minutes to complete. Data collection took place between September 2013 and May 2104.

All surveys were completed using the HDSS identity number. No subject names or other identifiers were recorded or stored in the same database as the completed survey forms. All surveys were entered into an MS Access database by members of the PiHP data entry team. All data were cleaned by the data manager prior to extraction into an excel spread sheet for analysis.

This report highlights the key findings from this survey. A brief description of the data is provided, by each site and all sites combined. No further analysis has taken place at this point in time.

This study was approved by the Medical Research Advisory Committee (MRAC) in Papua New Guinea and from the Behavioural & Social Sciences Ethical Review Committee (BSSERC) at the University of Queensland (UQ) in Australia.

12.2.1 Findings

A total of 541 women were identified across the three sites: Hiri (200); Karkar (216) and Asaro (125). A total of 482 women were surveyed: Hiri (173): Karkar (204) and Asaro (105). The 59 women were excluded due to refusal to participate, lack of study identity number or incomplete data collected.

Socio-demographic history

Just over half of the women surveyed (59%) were aged between 20-29 years; 23 women (6%) were aged 15- 19 years (Table 1). There was missing or incorrect data relating to age for 74 women, the majority from one site; a small proportion of these women did not know their age (13/74; 18%) did not know their age. Most women (446/480; 93%) were married or living as married. The majority of women (428/482; 89%) reported their occupation as housewife/ carrying out house hold duties.

Twenty two women (12%) from Hiri district reported being in paid employment, the majority employed either through the LNG project or the LNG/PiHP/PNGIMR programme. In Karkar and Asaro only two women– one at each site reported being in paid employment. Those living in Hiri were more likely to report having attended secondary education compared to those living in Karaka and Asaro (54%; 19% and 12% respectively). Twelve women (2.5%) reported having attended technical or vocational college or university; the three women who attended university were all from Hiri (Table 1). No women in Asaro reported higher than a secondary education (Table1).

Obstetric history

Just over half of the women (51%) had given birth once or twice previously; 17.5% had given birth five times or more (Table 2). Most women had given birth in either 2013 (41%) or 2012 (31%); 3.5% had given birth in 2010 (Table 2). The data presented in this report relates to each woman's most recent birth experience.

Antenatal care

Overall, 459 (95%) of women reported that they attended for antenatal care during their most recent pregnancy.Karkar had the highest proportion of women not attending for ANC – 16 women (8%) did not attend for any antenatal care compared to 2 (1%) and 5 (5%) respectively for Hiri and Asaro.

Of the 459 women who attended for antenatal care, 440 (96%) could recall their gestation at first attendance with the majority attending in the second trimester (326/440; 74%). Just 3% of women attended for antenatal care in the first trimester. Women in Karkar were more likely to present for antenatal care in the third trimester, compared with the other two sites (Table 3).

Four hundred and thirty women (430/459; 94%) recalled the number of antenatal visits they attended, with 72% attending antenatal clinic four or more times. A slightly higher proportion was seen in the women from Hiri (77%), compared to Karkar (63%) and Asaro (67%) (Table 3). Most women attended antenatal clinic at the health centre or aidpost (data not shown).

No woman received the full range of antenatal care at any of the three sites. Most women had their blood pressure checked (89%), an abdominal palpation (95%) and auscultation of the fetal heart (94%) with similar rates seen in all three sites (Table 3). Only half of all women reported having any blood test (Table3). Women were more likely to be tested for HIV and Syphilis than to have a haemoglobin estimation (Table 4). Of the 233 women who had a blood test, 40% reported that they did not know what the blood test was for (Table 4).

Coverage for tetanus toxoid, malaria prophylaxis and provision of iron supplements was similar in all sites (Table 4). Women in Karkar were less likely to receive a tetanus toxoid immunization compared with Hiri and Karkar. Women frequently stated that they did not take all the tablets provided, often because they did not feel they were necessary or because the tablets made them feel nauseated (data not shown). Just over half (53%) of all women received a mosquito net, but only 47% of the women in Karkar reported receiving one (Table 3). Most women (79%) were asked about their general health during their antenatal consultation and 80% were advised about where to give birth (Table 3).

Last birth experience

Most women (98%) had a normal, vaginal birth; six had caesarean sections and two had assisted vaginal births (Table 2). Nine women gave birth to twins; one from Hiri, five from Karkar and three from Asaro. There were 489 live births among the study population (Table 2); two women reported stillbirths – one each from Hiri and Karkar. Both women gave birth in the home; both infants were born at full-term, that is, between eight and nine months gestation. There were two early neonatal deaths reported in Asaro – one home birth and one born at hospital following a cord prolapse.

Overall, 311 women (65%) gave birth at a health facility (Table 2): 59% of births took place at a hospital and 39% in a health centre. There was one birth at an aid post (Table 5). Data regarding actual place of birth was missing for five women. Of the 311 women who gave birth in a health facility, only 87% were assisted during their birth by a trained health care worker (Table 5). Twenty one women (7%) were assisted by a relative, friend, their husband or a student nurse at the facility; 10 women (3%) gave birth alone. Data relating to specific assistant during birth was missing for eleven women.

Of the 171 (35%) women who gave birth in the community, 86% gave birth in their own home (Table 6). Six women (3.5%) gave birth while trying to reach a health facility (Table 6); two gave birth in vehicles, one gave birth on the beach while waiting for a vehicle; one gave birth just outside the family home; two gave birth on the roadside on the way to the facility. Most women (71%) were assisted by a female family member or a friend; 11% were assisted by a village birth attendant. Sixteen women (9%) gave birth alone. About half of the women who gave birth at home chose to do so,stating that it was convenient and their choice. Some women reported more than one reason to give birth at home, including: things were progressing too quickly; not enough time to get to a facility; lack of money for hospital fees and transport; and lack of transport. A few women stayed at home because they were afraid of the health care workers - either because of a fear of exposing their body or because they had not attended antenatal care and were afraid of being scolded. Other women mentioned that they did not have a guardian to take care of them at the facility or there were no relatives to take care of other children in the home.

Statistical analyses were conducted in Epi Info 7 to compare health facility births with parity, age and educational level. Compared to multiparous women, primiparous women were significantly more likely to give birth in a health facility (OR 2.39 [1.5, 3.8] P=0.0002). Those aged 15-24 years were also more significantly likely to have a health facility birth compared to all women aged 25 and over (OR 1.84 [1.19, 2.84]; p=0.007). There was no significant difference in women who attended primary education compared to secondary and tertiary education and health facility births (OR 0.67 [0.44-1.02]; p=>0.050). Multivariate analyses has not been undertaken at this time.

Problems experienced during pregnancy and childbirth

Overall there were 217 reported problems among the 482 women. Some women reported more than one problem. There were 116 (53%) reports of a problem during the pregnancy; 55 (25%) problems occurred during labour and 46 (21%) postpartum problems (Table 8). The most commonly reported problems were headache, oedema and dizziness; prolonged labour and excessive bleeding postpartum (Table 8).

Knowledge of danger signs in pregnancy and childbirth

One third of all the women (160; 33%) mentioned 283 danger signs in pregnancy and childbirth; some knew two or more danger signs. Many women knew these signs from personal experience or had been told by a female relative (usually an aunty). Some had learnt them through attending the antenatal clinic. Fever was the most frequently mentioned danger sign, followed by swelling of the limbs and bleeding in pregnancy (Figure 1).

Neonatal outcome and care

There were 489 live births among the 482 women. Gestation at birth was reported for 475 of the pregnancies (98%). Most infants were born after 8-9 months of completed pregnancy; 7% were born between 6-8 months of completed pregnancy. Birth weights were only available for 340 (70%) infants. Most births weights were missing among the infants born at home. Of the 340 infants for whom birth weight was recorded, 13.5% were of low birth weight; 148 (43.5%) weighed between 2.5-3 Kg (Table 9). In relation to breast feeding, data were not recorded for 29 (6%) infants and 5 infants (1%) were never breast fed. Of the remaining 455 infants, half (49%) were breast fed immediately following birth. A further 133 (29%) were breast fed within 1-2 hours after birth. 41 (9%) infants were not fed for more than 6 hours after their birth (Table 9).

Recognising danger signs in the newborn

Overall 297 (66%) women knew some danger signs in the newborn; 78% of these knew two or more danger signs. The most frequently mentioned danger sign was fever, followed by 'crying too much' (Figure 2). Overall, women's knowledge of danger signs was frequently due to past experience of sick infants.

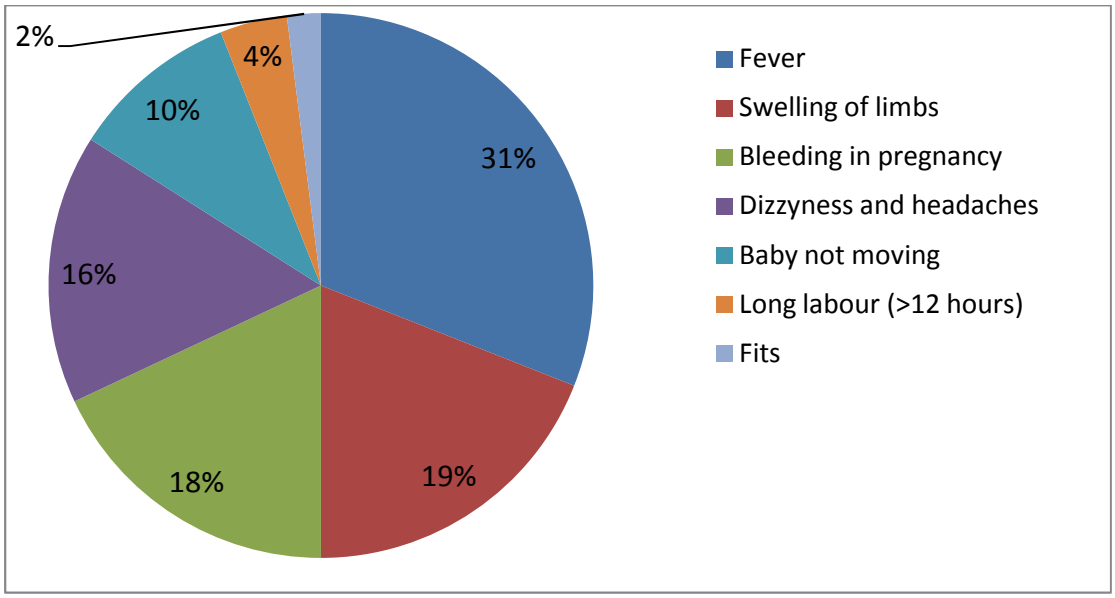

Figure 12-1: Women's knowledge of danger signs in pregnancy and childbirth (n=283)

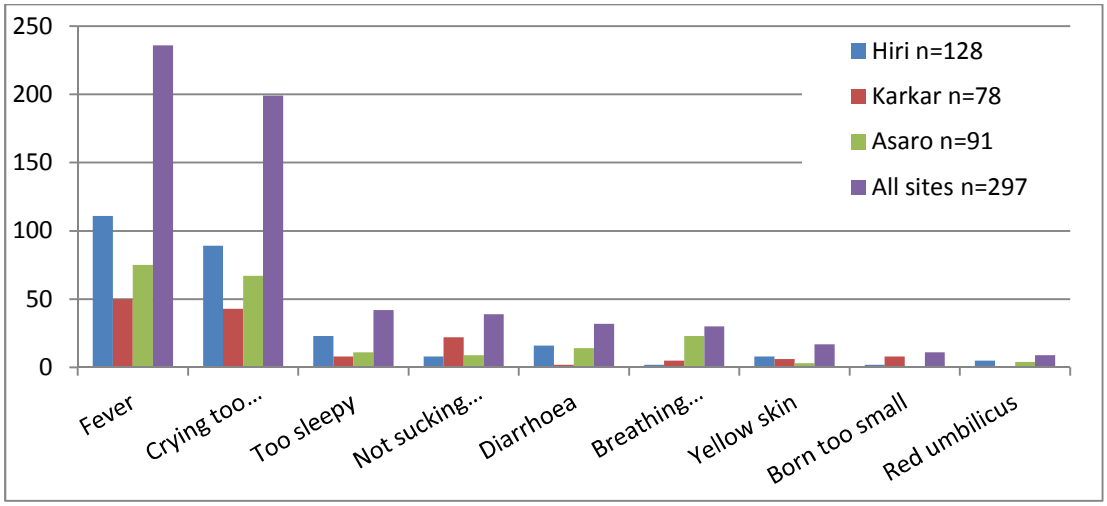

Figure 12-2. Newborn danger signs, by site

12.2.2 Discussion

The majority of women who participated in this survey had given birth in the previous year to 18 months. The study highlights that in these three sites, most women do attend for antenatal care at least once (96%) with nearly three quarters attendingfor the recommended minimum of four visits (72%). However, nearly one quarter of women present late for their first antenatal visit, presenting in the third trimester. There are differences noted between the three sites for both presentation for first antenatal visit and subsequent visits, with more women in Hiri reporting an earlier presentation for antenatal care and more visits compared with the other two sites. This may be due to their overall education level or due to access to the health facilities. Further analysis of this data set is required to identify any significant factors and differences relating to these areas of antenatal care.

Overall the standard of antenatal care does not meet the minimum standard requirements, as outlined by the PNG National Department of Health National guidelines for antenatal care. Across the various areas of care, our findings suggest that women are not receiving the full range of antenatal care services in these three sites (Table 3). The opportunity to monitor for risk factors in pregnancy, including pre-eclampsia, anaemia, HIV and syphilis are being missed. In addition, women and their unborn infant are at increased of pregnancy complications, such as malaria, due to limited issuing of mosquito nets and anti-malarial medications. The opportunity to provide women and their families with valuable health education about the importance of supervised births is also not being exploited fully.

Nearly two thirds of women (65%) are choosing to attend a health facility to give birth. However, some are giving birth alone in those facilities or with only the support of a family member. Many women giving birth in the community wished for a health facility birth but were hindered from reaching the facility because the labour progressed too quickly or because of financial and transport difficulties, and family constraints.

While significant differences are noted between health facility births and parity and younger age this data set would benefit from multivariate analysis to identify age, parity and education level and place of birth. It is possible that more of the multiparous women wanted to health facility birth but labour progressed too quickly leaving them giving birth before reaching a facility.

Nearly half of all women surveyed (45%) reported having experienced a problem during their last pregnancy or during childbirth. Most women experienced these problems during the pregnancy. Further analysis of the data is required to identify these complications and compare to uptake of antenatal care and place of birth.

Women's knowledge relating to both danger signs in pregnancy and childbirth and danger signs in a newborn infant tended to relate to personal experience, or was learnt from a family member.

Women were more likely to know danger signs in a newborn than in pregnancy and childbirth.

Fever was the danger sign most frequently reported for both infants and pregnant women. Further analysis of the data could highlight differences between women's educational level, parity, and knowledge of danger signs.

Three quarters of neonates were breast fed within the first two hours following birth, a practice important for a safer outcome for the neonate, especially given the proportion of low birth weight infants. Higher rates of low birth weight were noted in Karkar and Hiri when compared to Asaro.

Table 12-1. Socio-demographic data

Age n= 408		**Hiri N=173**		**Karkar N=144**		**Asaro N =91**		**All sites N= 408**	
		n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
	15-19	12	7	11	8	0	-	23	6
	20-24	49	28	41	28	29	32	119	29
	25-29	60	35	40	28	21	23	121	30
	30-34	32	18	27	19	27	30	86	21
	35-39	16	9	15	10	6	6	37	9
	40+	4	2	10	7	8	9	22	5
Marital status n = 480		**Hiri N=173**		**Karkar N=202**		**Asaro N =105**		**All sites N= 480**	
		n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
	Married	165	95	181	89	100	95	446	93
	Single	7	4	3	1	0	-	10	2
	Separated	1	1	16	8	4	4	21	4
	Widow	0	0	2	1	1	1	3	0.5
Employment n=482		**Hiri N=173**		**Karkar N=204**		**Asaro N =105**		**All sites N= 482**	
		n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
	No paid job	6	3	1	0.5	0	-	7	1.5
	Subsistence farmer	0	0	21	10	2	2	23	5
	HH duties/housewife	145	84	181	89	102	97	428	89
	Teacher	1	1	1	0.5	0	-	2	0.5
	Security guard	1	1	0	-	0	-	1	0.5
	Health care worker	0	-	0	-	1	1	1	0.5
	Other	20	12	0	-	0	-	20	4
Educational level n=480		**Hiri N=172**		**Karkar N=203**		**Asaro N =105**		**All sites N= 480**	
		n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
	No formal education	1	1	2	1	14	13	17	3.5
	Primary school only	70	41	157	77	78	74	305	63.5
	Grade 1-4	*4*	*6*	*22*	*14*	*34*	*44*	*60*	20
	Grade 5-8	*66*	*94*	*135*	*86*	*44*	*56*	*245*	80
	Secondary school	94	54	39	19	13	12	146	30
	Grade 9-10	76	81	37	95	13	100	126	86
	Grade 11-12	18	19	2	5	0	-	20	14
	Technical/vocational college	4	2	5	2	0	-	9	2
	University	3	2	0	0	0	-	3	0.5

Table 12-2. Obstetric history (n=482 women)

		Hiri N=173		Karkar N=204		Asaro N =105		All sites N= 482	
		n	%	n	%	n	%	n	%
Previous pregnancies	1	51	29.5	59	29	21	20	131	27
	2	49	28	48	23.5	20	19	117	24
	3	30	17	35	17	22	21	87	18
	4	18	10.5	28	14	18	17	64	13
	5	12	7	18	9	12	11	42	9
	>5	13	7.5	16	8	12	11	41	8.5
Year of most recent birth	2014	0	-	0	-	7	6.5	7	1.5
	2013	74	43	88	43	37	35	199	41
	2012	53	31	53	26	43	41	149	31
	2011	44	25	50	24.5	16	15	110	23
	2010	2	1	13	6.5	2	2	17	3.5
Location of most recent birth	Health Centre/ Hospital	116	67	118	58	74	70	308	64
	Village	57	33	86	42	31	30	174	36
Type of birth	Normal/ Vaginal	167	97	202	99	105	100	474	98
	Caesarean section	5	3	1	0.5	0	-	6	1.2
	Other - vacuum extraction	1	1	1	0.5	0	-	2	2
Outcome of infant	Live births	173*	-	208*	-	108*	-	489	-
	Stillbirths	1	1	1	0.5	0	-	2	0.5
	Neonatal deaths	0	-	0	-	2	2	2	0.5

*Twin births – 1 set Hiri, 5 sets Karkar, 3 sets Asaro

Table 12-3. AN care last pregnancy

		Hiri N=170		Karkar N=179		Asaro N=91		All sites N=440	
		n	%	n	%	n	%	n	%
Gestation at 1st AN	< 3 months	5	3	1	1	9	10	15	3
n=440	3-6 months	135	79	121	67	70	77	326	74
	6-9 months	30	18	57	32	12	13	99	23
Number AN visits		**Hiri N=168**		**Karkar N=177**		**Asaro N=85**		**All sites N=430**	
n=430		n	%	n	%	n	%	n	%
	1	7	4	8	4	2	2	17	4
	2	10	6	17	9	4	4	31	7
	3	22	13	36	19	12	12	70	16
	4	29	17	57	31	13	13	99	24
	>4	100	60	59	32	54	54	213	48
Care received at ANC		**Hiri N= 171**		**Karkar N=188**		**Asaro N= 100**		**All sites N=459**	
n=459		n	%	n	%	n	%	n	%
	Blood Pressure checked	156	91	162	86	90	90	408	89
	Urine test	37	21	24	13	8	8	69	15
	Any blood test	91	53	64	34	79	79	234	51
	Palpation	162	95	181	96	93	93	436	95
	Auscultation of fetal heart	161	94	176	94	93	93	430	94
	Checked for oedema	109	64	133	70	86	86	328	71
	Asked about general health	135	78	138	74	93	93	366	80
	Tetanus Toxoid given	151	88	145	77	84	84	380	83
	Malaria prophylaxis	132	77	155	82	83	83	373	81
	Worm tablets	47	27	75	40	45	45	167	36
	Iron tablets (fefol)	142	83	154	82	92	92	388	85
	Mosquito net provided	109	64	89	47	46	46	244	53
	Advised where to give birth	117	68	162	86	91	91	370	81

Table 12-4. Blood tests at ante natal clinic (n=233/459)

	Hiri N=91		Karkar N=63		Asaro N=79		All sites N=233	
	n	%	n	%	n	%	n	%
Hb	5	5.5	1	1.5	2	2.5	8	3
HIV	13	14	20	32	3	4	36	15
HIV, syphilis	28	31	4	6	18	23	50	21
HB, HIV, Syphilis	17	18	0	-	20	24	37	15
HB, HIV	2	2	2	3	5	6.5	9	4
HB, syphilis	0	-	0	-	2	2.5	2	1
Didn't know what blood test was for	26	32.5	36	57	29	37	91	40

Table 12-5. Health Facility births and supervision during childbirth (n= 311/482)

	Hiri N=117		Karkar N=118		Asaro N =76		All sites N= 311	
	n	%	n	%	n	%	n	%
Hospital	*92**	*79*	*58*	*49*	*33*	*44*	*183*	*59*
Health centre	*25*	*21*	*54*	*46*	*43***	*56*	*122*	*39*
Aid Post	*0*	-	*1*	*1*	*0*	-	*1*	*0.5*
Not known	*0*	-	*5*	*4*	*0*	-	*5*	*1.5*
Assisted by Health worker	98	84	103	87	68	91	269	87
Assisted by other	8***	7	9***	8	4***	5	21	7
Gave birth alone	8	7	0	-	2	3	10	3
Not known	3	2	6	5	1	1	11	3

*Includes 3 births at a private hospital

** Includes 2 births outside the health centre

*** Includes student nurses, husbands, female relatives and one VBA

Table 12-6. Births in the community (n= 171/482)

	Hiri N=56		Karkar N=86		Asaro N =29		All sites N=171	
	n	%	n	%	n	%	n	%
Gave birth in own home	*49*	*87.5*	*71*	*82.5*	*27*	*93*	*147*	86
Gave birth in others home	*2*	*3.5*	*8*	*9*	*0*	-	*10*	6
Other	*2**	*4*	*2***	*2*	*2*	*7*	*6*	4
Not known	*3*	*5*	*5*	*6*	*0*	-	*8*	5
Assisted by female family member/ friend	36	64	67	78	18	62	121	71
Assisted by Village birth attendant	12	21	7	8	0	-	19	11
Assisted by husband	2	4	2	2	0	-	4	2
Assisted by nurse in community	1	2	2	2	0	-	3	1
Gave birth alone	1	2	8	9	7	23	16	9
Not known	4	7	0	-	4	14	8	5

*one gave birth in a truck on the way to the health facility/ one gave birth on the beach waiting for transport

**one gave birth outside the house/ one gave birth in a truck on the way to the health facility

*** gave birth on the roadside on the way to the health centre

Table 12-7. Place of birth and parity/age/educational level

	Health Facility Births (n=311)									Home/Community Births (n=171)								
	Hiri		Karkar		Asaro		All sites			Hiri		Karkar		Asaro		All sites		OR (95% CI) / p-value*
	N=117		N=118		N=76		N=311			N=56		N=86		N=29		N=171		
	n	%	n	%	n	%	n	%		n	%	n	%	n	%	n	%	
Parity																		
Primiparous	41	35	42	36	19	25	102	33		10	18	17	20	2	7	29	17	2.39 (1.5,3.8) P=0.0002
Multiparous	76	65	76	64	57	75	209	67		46	82	69	80	27	93	142	83	0.4 (0.26,0.66) P=0.0002
Age																		
15-24 years	44	38	36	30	25	33	105	34		17	30	16	19	4	14	37	22	1.84 (1.19,2.84) p=0.007
25-34 years	61	52	32	27	33	43	126	40		31	55	35	41	15	52	81	47	0.75 (0.51,1.10) p=>0.05
35 + years	12	10	14	12	9	12	35	11		8	14	11	13	5	17	24	14	0.776 (0.44,1.35) p=>0.05
Not known	0	-	36	30	9	12	45	14		0	-	24	27	5	17	29	17	0.82 (0.49,1.37) p=> 0.05
Education level																		
No education	1	1	1	1	8	10	10	3		0	-	1	1	6	21	7	4	0.77 (0.29,2.08) p=>0.05
Grade 1-4	4	3	7	6	21	28	32	10		1	2	16	19	13	45	30	17	0.53 (0.3,0.9) p=0.032
Grade 5-8	36	30	73	62	35	46	144	46		30	53	62	72	9	31	101	59	0.59 (0.04,0.87) p=0.009
Grade 9-12	70	60	32	27	12	16	114	37		24	43	7	8	1	3	32	19	2.5 (1.6,3.9) p=0.0006
Tertiary/ University	6	5	5	4	0	-	11	4		1	2	0	-	0	-	1	1	6.23 (0.79,48.7) p=>0.05

*odds ratios (OR), 95% confidence intervals (CI) and p values calculated by comparing the proportion of women at all sites who had a health facility birth with the proportion of women at all sites who had a home/community birth.

Table 12-8. Reported problems during pregnancy and childbirth – last pregnancy (N=217)

	Hiri N=86		Karkar N=104		Asaro N =27		All sites N= 217	
	n	%	N	%	n	%	n	%
Problems in pregnancy	**58**	**67**	**42**	**40**	**16**	**14**	**116**	**53**
Headaches, dizziness or oedema lower limbs	22	38	12	28.5	2	13	*36*	31
Abdominal or back pain	9	15.5	8	19	4	26	*21*	18
Malaria	6	10	7	17	4	26	*17*	15
Fever	4	7	5	12	1	6.5	*10*	9
Nausea and vomiting	2	3.5	7	17	0	-	*9*	8
High blood pressure	6	10	0	-	0	-	*6*	5
*Other**	9	15.5	3	7	5	31	*17*	15
Problems in labour	**17**	**20**	**33**	**32**	**5**	**5**	**55**	**25**
Labour >12 hours	8	47	13	39	2	40	*23*	42
Breech	1	6	7	21	1	20	*9*	16
High Blood pressure	4	24	2	6	0	-	*6*	11
Obstructed labour	2	12	2	6	1	20	*5*	9
Bleeding before baby	1	6	3	9	1	20	*5*	9
Fits	0	-	5	15	0	-	*5*	9
Premature rupture membranes	1	6	0	-	0	-	*1*	2
Dizziness	0	-	1	3	0	-	*1*	2
Problems post-partum	**11**	**13**	**29**	**28**	**6**	**6**	**46**	**21**
Excessive bleeding after baby	6	55	17	59	4	66	20	43
Placenta took too long	3	27	9	31	0	-	8	17
Retained placenta	0	-	1	3	0	-	1	2
Other**	0	-	2	6	1	16	3	6.5
Not specified	2	18	0	-	1	16	3	6.5

*PV discharge (3), dysuria (5), anaemia (1), typhoid (2), PV bleeding (1), infected nipples (1), ovarian cyst (1), vomiting blood (1), diarrhea (1), APH (1)

** Dizziness, prolapsed rectum

Table 12-9. Last born Infant (n=489 live births)

		Hiri N=173		Karkar N=197		Asaro N =105		All sites N= 475	
		n	%	n	%	n	%	n	%
Gestation at birth	<6 months	1	0.5	0	-	0	-	1	0.5
n=475	6-8 months	15	8	11	6	9	8.5	35	7
	8-9 months	152	87.5	169	86	91	87	412	87
	>9months	6	4	16	8	5	4.5	27	5.5
		Hiri N=165		**Karkar N=116**		**Asaro N =59**		**All sites N= 340**	
		n	%	n	%	n	%	n	%
Birth weight*	<2.5 kg	19**	11.5	20**	17	7**	6	46	13.5
n=340	2.5-3.0 kg	77	47	57**	49	14	13	148	43.5
	3.05-3.5kg	52	31.5	29	25	21	19	102	30
	3.05-4 kg	14	8	7	6	11	10	32	9
	> 4kg	3	2	3	3	6	5.5	12	4
		Hiri N=163		**Karkar N=191**		**Asaro N =101**		**All sites N= 455**	
		n	%	n	%	n	%	n	%
Breast feeding	Immediately	113	69	86	45	23	22.5	222	49
n=455	1-2 hours	14	8	66	35	53	52.5	133	29
	2-6 hours	17	10	27	14	15	14.5	59	13
	6-12 hours	4	2	5	3	5	4.5	14	3
	>12 hours	15	9	7	3	5	4.5	27	6

* Birth weight is based on all births, including twin birth; excludes the 2 stillbirths

**includes one set twins in each fie

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13.0HEALTHY PREGNANCY STUDY

13.1 HEALTHY PREGNANCY STUDY

The epidemiology of sexually transmitted infections, including human papillomavirus, among pregnant women attending antenatal clinics at four sites in Papua New Guinea.

13.2 SUMMARY

Preliminary findings from this study indicate that pregnant women experience an unacceptably high burden of sexually transmitted infections (STI) in Papua New Guinea. The burden of curable STIs (chlamydia, gonorrhoea and trichomonas) was particularly high. Overall, 44% of women attending antenatal clinics in Hiri, Hides and Asaro had one or more of these infections, with the highest burden observed in Hides (53% prevalence). More than 80% of these infections were asymptomatic and therefore would not have been identified and treated based on current national syndromic management guidelines. Prevalences of syphilis and HIV infection were also high (2.2% and 1.3% respectively for the three sites combined), and confirm the country's place among the highest burden nations worldwide for maternal syphilis infection. This study is also providing the country's first general population level estimates of human papillomavirus (HPV) type prevalence, and is expected to inform national policy on HPV vaccination and cervical cancer prevention.

13.3 STUDY AIMS AND OBJECTIVES

The overallAim of this study is to investigate the epidemiology of HIV, human papillomavirus(HPV) and other sexually transmitted infections (STIs) among pregnant women attending antenatal clinics at three sites in Papua New Guinea. The study has the following Research Objectives:

1. To provide the first robust estimates of *C. trachomatis, N. gonorrhoeae, T. vaginalis*and*Herpes simplex* type-2 (HSV-2) prevalence among pregnant women in PNG;
2. To provide the first general population estimates of human papillomavirus (HPV) prevalence among women in PNG in order to inform national policy on HPV vaccination;
3. To validate estimates of antenatal HIV and syphilis prevalence obtained through national antenatal surveillance;
4. To investigate the demographic and sexual behavioural correlates of HIV, HPV and STI risk among women attending antenatal clinics at these sites.

13.4 INTRODUCTION

Papua New Guinea (PNG) has among the highest prevalences of HIV, syphilis and other sexually transmitted infections (STIs) in the Asia-Pacificregion[1-8]. The HIV epidemic in PNG is primarily linked to heterosexual transmission, with over half of reported HIV diagnoses coming from three of its 22 provinces[5, 9]. Adult HIV prevalence is currently estimated at 0.9%[5], however prevalences of 12-17% have been reported among women and men who sell and/or exchange sex[10, 11] and antenatal HIV prevalences around 2.0% have been reported from several Highland provinces[9]. PNG is among 12 high-burden countries selected by the World Health Organization (WHO) for intensified support for the elimination of mother to child transmission of syphilis[2]. PNG also has one of the highest estimated burdens of cervical cancer globally, with an age-standardized incidence of 23.7/100,000, compared to 5.0/100,000 in Australia[12].

Sexually transmitted infections (STIs) are associated with significant adverse reproductive health outcomes, particularly among women[13-15]. In pregnant women with untreated early syphilis, 25% of pregnancies result in stillbirth and 14% in neonatal death[15, 16]. Up to 35% of pregnancies among women with untreated gonorrhoea are estimated to result in spontaneous abortion and premature deliveries, and up to 10% in perinatal death[15, 16]. In the absence of prophylaxis, 30 - 50% of infants born to mothers with untreated gonorrhoea and up to 30% of infants born to mothers with untreated chlamydia will develop ophthalmianeonatorum, which can lead to blindness if not diagnosed and treated promptly[15]. Untreated chlamydia or gonorrohoea can result in chronic salpingitis leading to infertility or ectopic pregnancy.

In addition to their direct effects on reproductive health, many STIs have been shown to biologically enhance the transmission and acquisition of HIV[17-24], so that their effective management may play an important role in HIV prevention, particularly in resource-limited settings[25-29].

As is the case with many developing countries, PNG could benefit from better information on the extent of STIs to inform national prevention and control strategies. This study will provide the first robust estimates of STI prevalences among pregnant women, including the first estimates of HPV and HSV-2 infection.

13.4.1 Sexually transmitted infections in the Asia-Pacific region

In a recent six country study among 1678 pregnant women attending urban and rural antenatal clinics in Fiji, Kiribati, Samoa, Solomon Islands, Tonga and Vanuatu, the prevalence of chlamydia was 6.4-29.0% (mean 18.0%); gonorrhoea, 0.0-2.5% (mean 1.7%); and syphilis, 0.0–10.0% (mean 3.0%) in the period 2004-2005[30]. None of the 1618/1678 clinic attenders who underwent voluntary counselling and confidential HIV testing (VCT) were HIV sero-positive[30, 31]. Chlamydia was the most prevalent STI, particularly in Fiji (29.0%) and Samoa (26.8%). Chlamydia was more prevalent in younger women in all locations[11]. For example, in Tonga, prevalence among women <25y was 27.5%, compared to 8.3% among women >25y; in Samoa prevalences of 40.7% and 17.5% were observed in these age-groups respectively[31]. Only 1.5% of the 1678 antenatal clinic attenders reported transactional or commercial sex in the previous 12-months, but these women were six times more likely to have chlamydia infection[31]. High rates of STIs among pregnant women, including chlamydia (21.5%), gonorrhoea (5.9%), HSV-2 (30.0%), syphilis (2.4%) and trichomonas

(27.5%), have also been reported previously in Vanuatu[32-34] and similar rates observed in Fiji[35] and Samoa[36]. Among 451 antenatal clinic attenders in Cambodia, the prevalence of chlamydia was 2.8%; gonorrhoea, 0.0%; syphilis, 1.3%; and trichomonas 2.7%[37]. In a general population survey among 2550 women and 1350 men in the Philippines, the prevalence of chlamydia was 5.7%, gonorrhoea 0.8%, and syphilis 0.2% among women; and 4.4%, 1.1% and 0.2% among men, respectively[38].

13.4.2 Sexually transmitted infections in Papua New Guinea

High prevalences of HIV, STIs and genital infections have been reported among men and women in PNG in comparison to other countries in the Asia-Pacific region[39-65]. A recent systematic review and meta-analysis of HIV/STI prevalences in community and clinic-based settings in PNG[11] however, identified only 3 epidemiological studies conducted to date among pregnant women; a combined total of 206 antenatal clinic attenders[47] and 736 women presenting in labour[50, 57] (Table XX).

Table 13-1. Summary of published data on antenatal HIV/STI prevalences in PNG

Author	**Klufio et al., 1995[47]**	**Mgone et al., 1997[50]**	**Suarkia et al., 1999[57]**
Study population	**206 pregnant women attending first antenatal clinic visit at Port Moresby General Hospital**	**155 women presenting in labour to Goroka Base Hospital**	**581 women presenting in labour to Goroka Base Hospital**
Bacterial vaginosis	23.3 (17.7, 29.7)	-	-
C. trachomatis	17.7 (12.4, 24.0)	36.8 (29.2, 44.9)	34.1 (30.2, 38.1)
N. gonorrhoeae	-	-	-
Syphilis	-	-	-
T. vaginalis	18.9 (13.8, 25.0)	-	-
HIV	-	-	-
HSV-2	-	-	-

Periodic syphilis and HIV sero-surveys are conducted by the National Department of Health (NDoH) in PNG to support routine antenatal surveillance. In 2010, estimated antenatal syphilis prevalence was 6.9%, and HIV prevalence 0.7% in urban areas (N=4623) and 4.2% and 0.5% respectively in rural areas (N=3180) (*NDoH, personal communication*). No prevalence estimates of HSV-2 or HPV have previously been reported among pregnant women in PNG[11].

The reasons for the differences in the epidemiology of HIV and STIs in PNG compared to other countries in the Asia-Pacific region are unclear, but felt likely to be the result of locally-specific interactions between the behavioural determinants, socio-cultural dimensions and structural contexts that frame sexual agency, sexuality and sexual health in PNG compared to other settings[66-*75*]. These include gender power disparities, sexual violence and the societal roles of men and women[66-69, 72, 74-76]; low levels of male and female condom use[53, 61, 77], and of male circumcision[67, 76, 78, 79]; limited access to STI treatment services due to poor transport and health systems infrastructure[80, 81]; and limited success in the design and implementation of

culturally-relevant behaviour change interventions among both general population and at-risk groups, such as truck drivers, male and female sex workers and their clients[67, 79, 82]. These factors may also explain the high HIV/STI prevalences observed in Tanah Papua Province in Eastern Indonesia, which is experiencing a generalised HIV epidemic that has many parallels to that of neighbouring PNG[83].

13.4.3 HPV and cervical cancer in PNG

Cervical cancer is the most common cancer among women in PNG and a leading cause of premature death[8, 84]. An estimated 1500 women die every year in PNG due to cervical cancer. Despite this burden of disease, no large-scale surveys have been conducted to establish the prevalence of HPV among general or at-risk populations of women. The only survey published to date was conducted among 114 women in Eastern Highlands Province, which reported a 33% prevalence of HPV-16/18[85]. More recently, cervical biopsies obtained over the period 2006-09 from 70 women in PNG with cervical cancer were analysed for HPV infection[4]. HPV-DNA was found in all cases with HPV-16, 18, 33 and 31 the most prevalent HR types (57%, 26%, 10% and 4% respectively). These findings suggest that the currently available and highly effective vaccines against HPV types 16 and 18 have the potential to significantly reduce the burden of HPV-related cervical cancer in PNG, if distribution and cost issues can be resolved.

13.4.4 PNGIMR collaborative research program in sexual and reproductive health

The PiHHealthy Pregnancy Study is part of a broader program of research being undertaken by the PNGIMR collaborative research group in sexual and reproductive healththat has been led by A/Prof Vallely (PNGIMR/UNSW) since 2007. This program includes research on the epidemiology, prevention and control of HIV, HPV and other STIs, and interventions research in cervical cancer and maternal and neonatal health.

Complimentary research among 1000 women attending well woman and sexual health clinics in Eastern and Western Highlands Provincesis also being conducted by our group under a separate funding mechanism, and will provide data on HPV genotype prevalence among women at different levels of sexual risk. These studies will together provide the necessary policy-relevant evidence required to inform locally-appropriate and effective interventions for the prevention of cervical cancer in PNG.

13.5 METHODS

The PiH Healthy Pregnancy Study is a cross-sectional bio-behavioural survey among pregnant women attending antenatal clinics in Central, Eastern Highlands and Hela Provinces. A target recruitment total of 250 women per site was selected in order to enable the study to estimate STI prevalences with adequate precision at site-level, in addition to providing robust estimates of prevalence across all sites. For example, this sample size enables a chlamydia prevalence of 18% across all sites combined to be estimated with around 2.4% precision (i.e. 95% CI: 15.6, 20.4), and a prevalence of 18% at a single siteto be estimated with around 4.8% precision (i.e. 95% CI: 13.2, 22.8).

The study was approved by the Medical Research Advisory Committee (MRAC) of the National Department of Health (NDoH) in Papua New Guinea; and the Health Research Ethics Committees of the University of New South Wales (UNSW) and the Alfred Hospital in Australia.

13.6 FINDINGS

13.6.1 Recruitment and sites

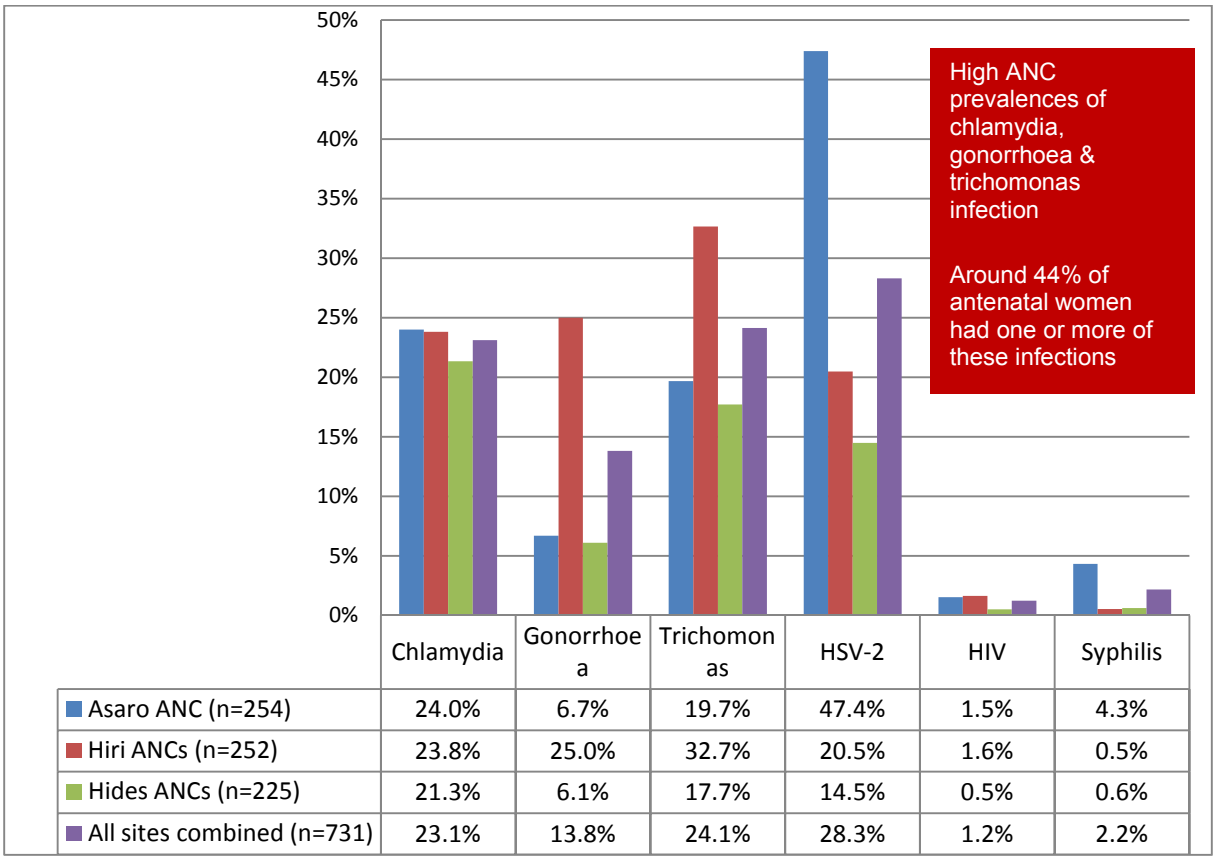
Recruitment at all three participating sites was completed in mid-2014, with a total of 765 participants recruited overall(Hiri, n=255;Asaro,n=258; Hides,n=252), As a result of funding and logistics constraints, a decision was made in early 2014 not to proceed with a fourth study site in Karkar. Laboratory analyses were completed in late 2014 and test results provided to study participants at each site.

13.6.2 Prevalences of HIV and sexually transmitted infections

High prevalences of HIV, syphilis, chlamydia, gonorrhoea and trichomonas were observed in this setting (Figure xx). The prevalences of syphilis and HIV infection were 2.2% and 1.2% respectively for the three sites combined. Overall, 44% of women attending antenatal clinics in Hiri, Hides and Asaro had one or more of chlamydia, gonorrhoea and trichomonas infections, with the highest burden observed in Hides (53% prevalence). More than 80% of these infections were asymptomatic and therefore would not have been identified and treated based on current national syndromic management guidelines. Similar STI prevalences were reported in a malaria in pregnancy trial conducted by the PNGIMR and international collaborators in Madang, in which over 60% of antenatal women with an STI were found to be asymptomatic[86].

The prevalences of HIV and syphilis observed in Hiri, Hides and Asaro are broadly consistent with routine National Department of Health antenatal surveillance data. HIV estimates from the Healthy Pregnancy study need to be interpreted with caution particularly at the level of individual sites however, due to the modest sample size per site and the low prevalence of HIV in the general population, which mean that the confidence intervals around these estimates will be relatively broad compared to estimates of more prevalent infections such as chlamydia or trichomonas.

Figure 13-1. Prevalences of HIV and other STIs among 731 women attending 6 antenatal clinics at 3 sites in PNG



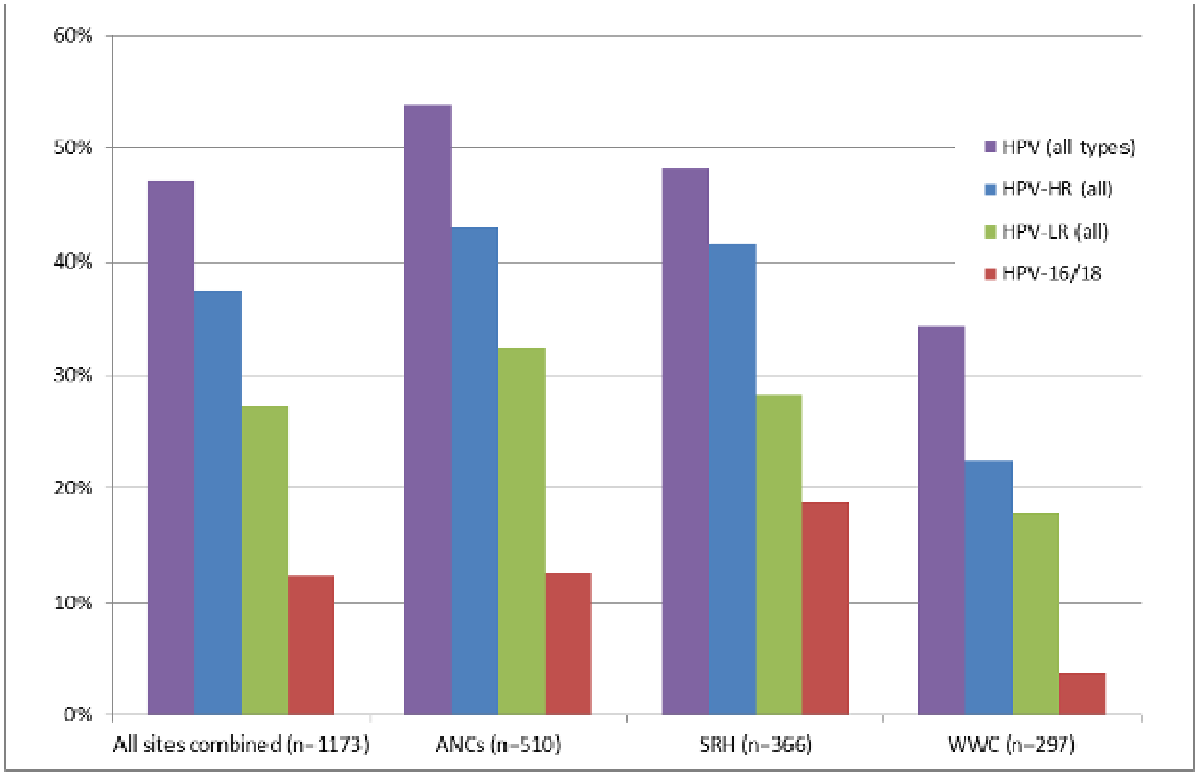
	Chlamydia	Gonorrhoea	Trichomonas	HSV-2	HIV	Syphilis
Asaro ANC (n=254)	24.0%	6.7%	19.7%	47.4%	1.5%	4.3%
Hiri ANCs (n=252)	23.8%	25.0%	32.7%	20.5%	1.6%	0.5%
Hides ANCs (n=225)	21.3%	6.1%	17.7%	14.5%	0.5%	0.6%
All sites combined (n=731)	23.1%	13.8%	24.1%	28.3%	1.2%	2.2%

13.6.3 Prevalence of human papillomavirus (HPV) infection

The prevalence of HPV infection was high in this population compared to prevalences among women attending sexual health or well woman clinics in this setting, reflecting the younger median age of antenatal women compared to other clinic attendees (24 years, 33 years and 36 years respectively) (Figure xx).

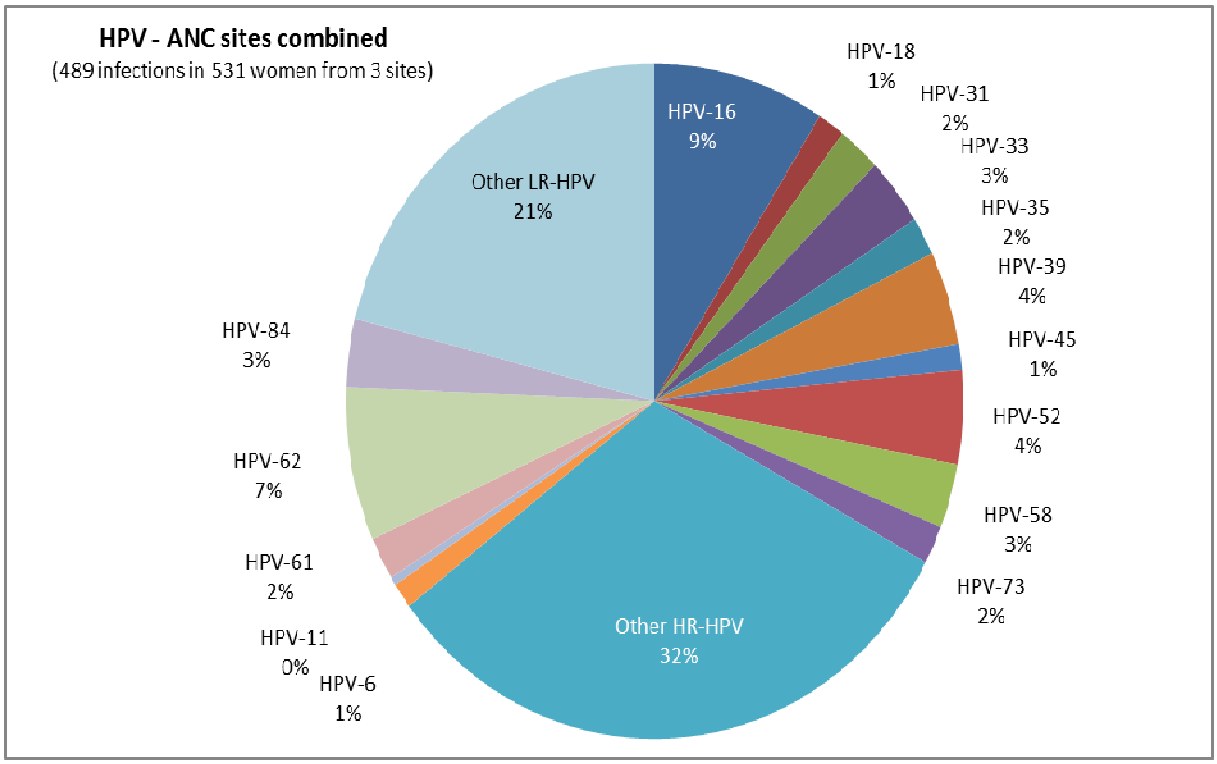
The prevalence of high risk HPV infection (all types combined) was 43% overall (Hides=26%; Hiri=44%; Asaro=49%) and that of HPV types 16 or 18 was 13% across all sites (Hides=3%; Hiri=10%; Asaro=18%). Among women with an HPV infection, the most prevalent high risk HPV types were HPV 16, 39, 52, 58 and 33 (Figure xx).

Figure 13-2. Prevalences of HPVamong 1173 women attending antenatal, sexual health and well woman clinics in PNG



ANC: antenatal clinic; SRH: sexual & reproductive health clinic; WWC: well woman clinic

Figure 13-3. HPV types among HPV positive women attending antenatal clinics at three sites in PNG



13.7 DISCUSSION

The PiH Healthy Pregnancy Study is a landmark study in reproductive health in Papua New Guinea and provides the first contemporary prevalence estimates of sexually transmitted infections (STIs) among antenatal women in this setting. As indicated in research led by the PNGIMR in the 1990s and National Department of Health surveillance data on syphilis and HIV infection, pregnant women in PNG continue to experience an unacceptably high burden of STIs. The burden of curable STIs (chlamydia, gonorrhoea and trichomonas) appears to be particularly high and this health need is currently unmet through existing syndromic management approaches due to the majority of pregnant women having no clinical symptoms. These findingssuggest that new strategies are needed to control STIs and their associated adverse maternal and neonatal health outcomes in this population. Arising from this research, the PNGIMR collaborative research group completed a pilot intervention study among antenatal women in 2014 that confirmed the operational feasibility and potential public health impact of newly-available, robust and highly accurate point-of-care STI tests for the diagnosis and treatment of STIs in pregnancy. This research lead to a successful NHMRC Project Grant application that will allow the PNGIMR and in-country stakeholders and partners to formally evaluate the potential public health impact of point-of-care STI testing and treatment to improve pregnancy outcome sin this setting.

The Healthy Pregnancy Study is providing the first geographical, age and type-specific prevalence data on HPV infection in PNG. Together with data from women attending sexual health and well woman clinics, these findings suggest that polyvalent HPV vaccines could have a significant impact in preventing cervical cancer in PNG, a country with one of the highest burdens of cervical cancer globally. Discussions between the PNGIMR collaborative research group, the National Department of Health, and key development partners (including WHO, GAVI and Rotary International) regarding the conduct of robust district and provincial level HPV vaccine pilot intervention studies are on-going. The successful conduct of these studies will be critical to the successful future wide-scale introduction of HPV vaccines in PNG.

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14.0TUBERCULOSIS

Tuberculosis epidemiology research in partnership in health project (TB/PiH)

PNG Institute of Medical Research
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List of Investigators

Dr. Suparat Phuanukoonnon (Lead investigator and author)

(suparatp@hotmail.com) (phuanukoonnon@wehi.edu.au)

Dr. Paul Harino
Dr. Gail Cross
Dr. Kate Coles
Dr. Patricia Rarau
Dr. Regina Wangnapi
And Prof. Peter Siba

Clinical/field team

Kikori: Dr. Paul Harino, Ronnie Boli, Beveryn Warigi, Sulia Sobam, Gabe Luke, Kua Ulka, Gaima Kaumi, Ihere Tuvarau
Hiri: Dr. Patricia Rarau, Roselyn Nopa, and Jeff Norman
Karkar: Dr. Regina Wangnapi, Campbell Asuak, Ken Yaku, Walarus Manup; Jacob Kumai
Hides: Emmanuel Hapolo, Ronnie Boli, Campbell Asuak, and Ken Yaku

Laboratory team

Kikori hospital: Dr. Kate Coles, Beverlyn Warigi, and Francesca Popsy
IMR/UPNG lab, POM: Jonah Iga, Rosemary Simbil, Beveryn Warigi
IMR/DWU lab, Madang: Francesca Popsy, Issac Niginamb, Connelia Duba.

Collaborators

Queensland Mycobacterium Reference Laboratory, Queensland Health
Dr. Christopher Coulter, Dr. Sushil Pandry, Ms Robyn Carter
Walter and Eliza Hall Institute of Medical Research (Infection and Immunity Unit)
Prof. Ivo Mueller, Dr. Marc Pellegrini and Prof. Louis Schofield

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ABBREVIATIONS

ACD	Active Case Detection
AFB	Acid Fast Bacilli
AIDS	Acquired Immune Deficiency Syndrome
BCG	Bacillus Calmette-Guérin
BMI	Body Mass Index
CHIKV	Chikungunya virus
CI	Confidence Interval
CP	Central Province
CRF	Study-specific case record forms
DNA	Deoxyribonucleic acid
DOTS	Directly Observed Therapy - Short Course
DSS	Demographic Surveillance Survey
DST	Drug Sensitivity Test
DWU	Divine World University
GIS	Geographic Information System
GPS	Global Positioning System
HIV	Human Immunodeficiency Virus
iHDSS	Integrated Health and Demographic Surveillance Survey
IMR	Institute of Medical Research
MDR/TB	Multiple drug resistant tuberculosis
MGIT	Mycobacteria Growth Indicator Tube
MIRU-VNTR	multilocus mycobacterial interspersed repetitive unit variable number of tandem repeats
MRAC	The PNG Medical Research Advisory Committee
MTB	*Mycobacterium Tuberculosis*
N/A	Not applicable
NDoH	National Department of Health
PCD	Passive case Detection
PCR	Polymerase chain reaction
PICT	Provider-initiated HIV counseling and testing
PiHP	Partnership in Health Project
PNG	Papua New Guinea
PNGIMR	Papua New Guinea Institute of Medical Research
PNGLNG	Papua New Guinea Liquefied Natural Gas
POM	Port Moresby
PTB	Pulmonary Tuberculosis
QMRL	Queensland Mycobacterium Reference Laboratory
RIF	Rifampicin
TB	Tuberculosis
WHO	World Health Organization
WPR	Western Pacific Region
ZN	Ziehl-Neelsen stains

14.1 EXECUTIVE SUMMARY

This report presents the findings of the multi-site tuberculosis (TB) research programme that was developed and executed as a sub-study under the Partnership in Health Project (PiHP). The TB study began in 2012 and continued until late 2014. The TB programme was conducted at three integrated Health and Demography Surveillance Site (iHDSS), i.e., Hiri, Hides and Karkar Island. While not a formal iHDSS, a fourth location, Kikori (Gulf Province) was also intensely investigated as part of the programme. The Kikori area was an active PNGLNG construction area and had previously been identified as a potential "TB hot spot" during the execution of the 2008 pre-project Health Impact Assessment. Hiri and Hides were both active PNGLNG construction locations and will continue to be critical sites for the duration of active operations. Karkar Island is a distant, coastal comparison location for Hiri. The fourth iHDSS site, Asaro (a Highlands comparison location to Hides) was not, at this time, part of the active research effort. Collecting comparable comparison TB data in Asaro (in order to compare to Hides) is extremely complicated methodologically to determine if TB cases were actually from the Asaro iHDSS catchment area; hence, a detailed investigation was not undertaken at this time for the Asaro site.

This report consists of an introduction followed by four chapters:

- Chapter 1 Kikori (Gulf Province)- the TB epidemiology of a perspective hospital based study.

The incidence and characteristics of TB in remote, rural areas of PNG are largely unknown. The purpose of the study was to determine the incidence of TB in Kikori and describe disease characteristics, co-morbidities and drug resistance profiles that could impact disease outcomes and transmission.

PNGIMR estimated the incidence of TB in Kikori to be 1130 per 100,000 people (95% CI 1000 to 1300) in 2012.

Global Incidence of TB

Country	Per 100, 000 pop
Swaziland	1287
South Africa	981
Timor-Leste	498
D. Republic of Congo	327
Papua New Guinea	303
Kikori	**1130**
Indonesia	189
India	185
Russian federation	106
China	80
Australia	6.3

Source: WHO, Global Tuberculosis Report, 2011

The proportion of TB patients co-infected with HIV was 1.9%, an extremely low value particularly in comparison to sub-Saharan Africa. According to WHO, people living with HIV are from 26-31 times more likely to develop TB than persons without HIV. In parts of sub-Saharan Africa, up to 70% of TB patients are co-infected with HIV.

Three of 37 TB cases tested were rifampicin resistant. Typing of nine isolates demonstrated allelic diversity and most were related to Beijing strains.The incidence of TB in Kikori is one of the highest in the world and the high rate is not driven by HIV co-infection. The high incidence and the presence of rifampicin resistant warrant urgent attention and public health intervention by the relevant government authorities in order to (i) mitigate substantial morbidity in the region and (ii) prevent an expanding and explosive outbreak of TB and MDR-TB in PNG.

- Chapter 2 Kikori TB treatment cohort study.

Beginning in July 2012, participants in this study were enrolled and followed through the course of their treatment. The TB treatment cohort is a separate and distinct group from the patients described in Chapter 1. The TB treatment cohort showed similar risk factors to general, non-study TB patients in Kikori, i.e., frequent exposure to indoor smoke, high household population size and presence or absence of BCG vaccination. The underlying burden of TB was high as one third had a previous history of TB illness. Sophisticated laboratory methods, i.e., the use of GeneXpert testing, substantially improved the sensitivity of TB detection. Integrating GeneXpert technology into a rural hospital setting was achieved without undue difficulty. A 'Directly Observed treatment, Short–Course (DOTS) intervention was initiated for the study group. DOTS is a well established World Health Organization treatment programme that has been utilized globally. DOTS can be executed in rural PNG; however, in order to be successful a strategic plan, using operational research assessment methods, (as conducted in this study), is necessary to complement routine DOTS activities. The combination of standard DOTS plus effective operations research methods achieved a greater than 80% satisfactory treatment outcome.

- Chapter 3 is the Tuberculosis Active Case Detection Study conducted in Kikori, Hiri iHDSS, Karkar iHDSS and Hides iHDSS.

The summary of TB surveillance survey results covering all sites over the 2013-2014 is shown below.

Summary of TB surveillance survey results in 2013-2014

	Hiri	**Kikori**	**Hides**	**Karkar**
Number of villages	4	21	4 wards	21
Total population survey	13310	9670	5596	18413
TB diagnosed from Active case detection	16	22	2	22
% of TB detection by ACD	23%*	14%	22%	16%
TB rate from ACD (per 100000)	120	227	36	119
TB diagnosed from Passive case detection	34	137	7	114
% of TB detection by PCD	50%*	86%	78%	84%
TB rate from PCD (per 100000)	255	1417	125	619
TB prevalence (per 100000)	510**	1644	160	738
TB incidence (per 100000)	458	1290	36	630
TB incidence rate reported by NDOH (2013)	165	815	84***	276***
RIF+ from GeneXpert	4	2	0	0
Proportion of PTB vs. Extra PTB	72 vs. 28	32 vs. 68	44 vs. 56	67 vs. 33
Prolonged cough seeking health care	29%	63%	N/A	N/A

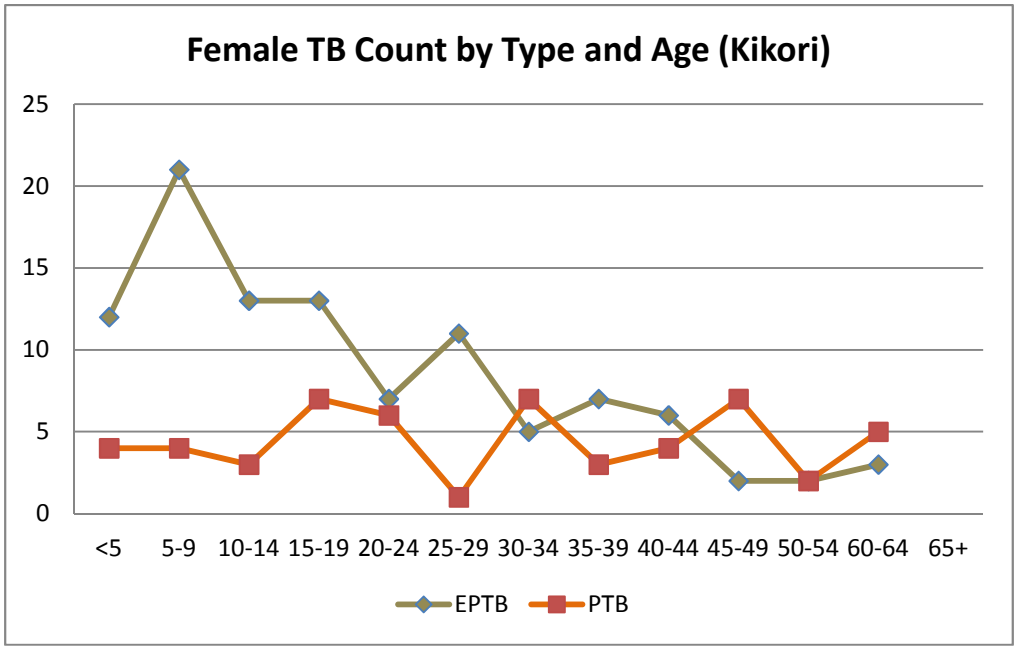
* These percentages were calculated from the total number of TB cases (n=68; 16 from ACD + 34 from PCD + 18 from the PNGLNG plant site)

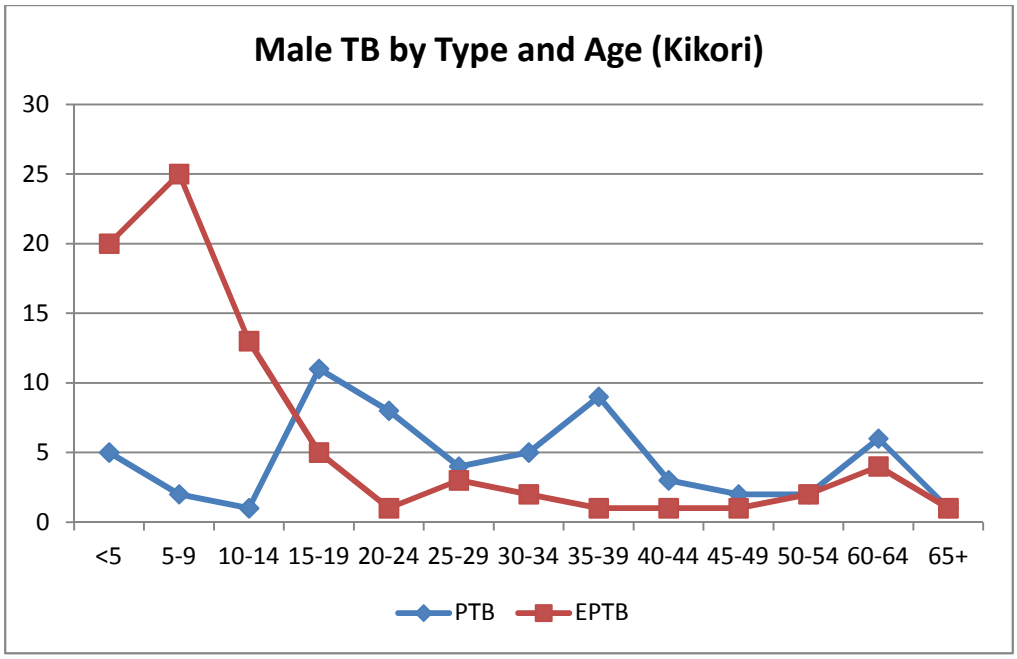
** The numerator calculated in this prevalence rate was 68; included 18 TB cases diagnosed by ISOS from the PNGLNG project.

***This rate was for the year 2012

The PNGIMR study found that TB in rural villages in Kikori was extremely high, i.e., the TB incidence was 1290/100,000 pop. The TB incidence was significantly higher than the incidence rate estimated by the NDOH (Gulf 785/100,000 pop). The sensitivity of acid-fast bacillus (AFB) microscopy was 60% in this study. GeneXpert greatly increased the sensitivity of TB diagnosis, by detecting an additional 40% of pulmonary TB (PTB), in the set of AFB "negative" microscopy results.

TB patterns varied across the different study locations. PTB cases were more dominant in Karkar (67%) than in Kikori (32%), which had a very high percentage of extra pulmonary TB. Age/sex and PTB versus EPTB for Kikori illustrate the demographics of TB in Kikori.





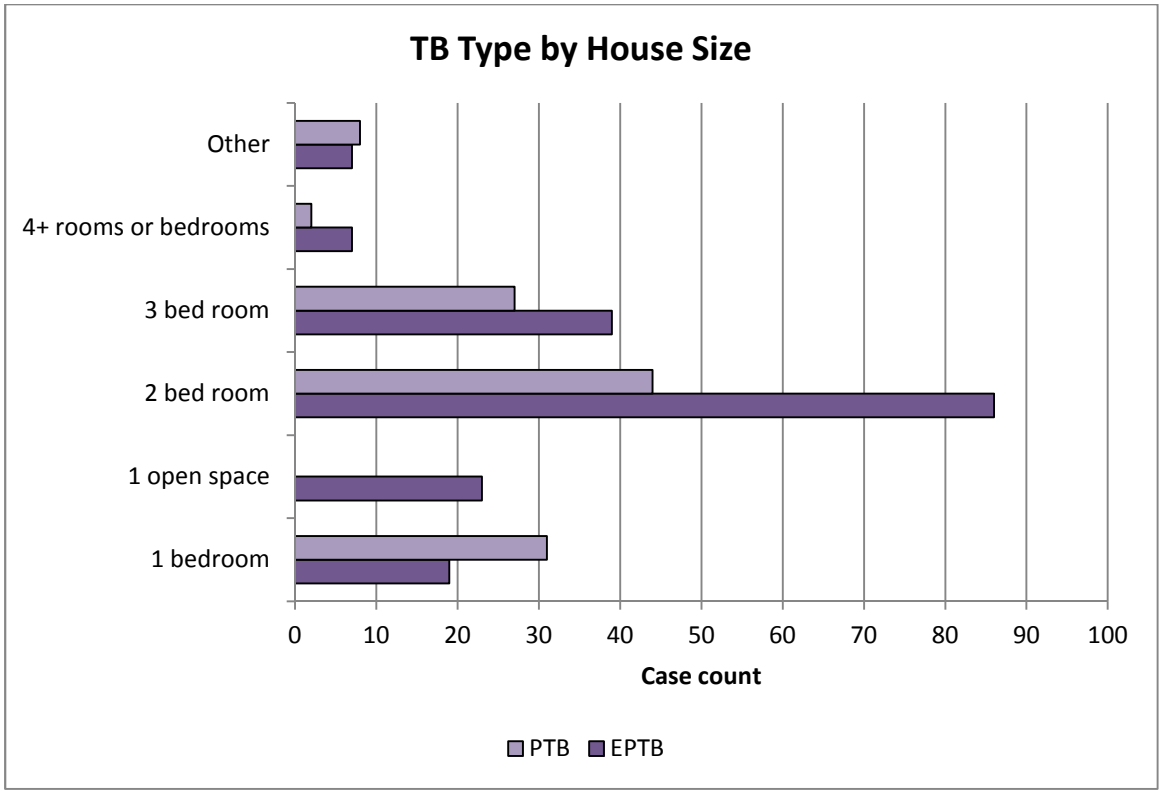
Despite long distance to health facilities, 61% of prolonged cough patients in Kikori sought diagnosis and care at health facilities. The Passive Case Detection (PCD) in Kikori and Karkar had detected most TB cases (86% Kikori, 84% Karkar), which successfully reached the PNG National TB Control Plan of 70% of TB case detection. The tuberculosis (TB) case detection rate (CDR) is the ratio of the number of notified TB cases to the number of incident TB cases in a given year. According to WHO, one key target for TB control programmes worldwide is achieving a sputum smear-positive CDR greater than 70%.

- Chapter 4 - Knowledge, Attitude and Practice (KAP) survey on TB.

The KAP survey develops evidence for interventions in order to improve the prevention, care, and treatment of TB in the community. The results of this study showed that participants from Hiri iHDSS had more knowledge and understanding on cause of TB and TB transmission than those from comparison iHDSS locations at Asaro and Karkar. However, misperceptions were common across the three study sites. For example, many individuals believe that TB infection could be via skin contact, sharing food, and using same utensils as actively treated TB patients. Approximately 30-40% of respondents did not know the duration of TB treatment. The majority of the study population study did not believe that BCG vaccination that could help prevent TB. Stigma and discrimination against TB patients and their family are quite common in the study communities.

14.2 Key Findings

Overall, the PiHP sponsored TB research programme has developed new, critical data describing the magnitude of the TB problem across a variety of PNG locations. Rates of TB were extremely high in Kikori, Hiri and Karkar Island and substantially above levels reported by the National Department of Health. Fortunately, the TB burden in Hides is quite low. The burden of TB is at epidemic levels, particularly in Kikori, where high levels of multi-drug resistant TB are also present. Increases in household size without concomitant increases in the household physical setting, and the presence of young children dramatically increase transmission risk. Data from Kikori illustrate the strong relationship between TB, TB type and house size.



The presence or absence of BCG vaccination is also critical as those individuals who had a BCG scar were 91% less likely to have TB.

The need for urgent intervention, including aggressive vaccination campaigns, and concerted effort by the national government and its partners is clear. A focused DOTS plus outreach effort can be successfully implemented; however, the KAP survey demonstrates that there are significant information and awareness hurdles that must be overcome. High household occupancy levels in crowded conditions are a structural/economic problem that will be very difficult to address. Economic advancement and develop, particularly in Kikori has a critical role; however, the rapid population movement that can be triggered by large projects also potentially poses a significant risk for TB dissemination, including MDR-TB. The problems are complex and intertwined; hence, an integrated approach is required. The PNGIMR studies provide crucial baseline data so that public health officials can begin to address this TB epidemic.

14.3 INTRODUCTION

Tuberculosis (TB) is primarily a disease of the respiratory system, and is spread by coughing and sneezing. Approximately, a third of the world's population is to be infected with *M. tuberculosis.* Most infections in humans result in an asymptomatic, latent TB infection known as LTBI. About one in ten latent infections eventually progresses to active disease, which, if left untreated, kills more than 50% of these TB cases. In 2007 there were an estimated 13.7 million active TB cases, 9.3 million new cases, and 1.8 million deaths, mostly in developing countries (1). According to WHO, people living with HIV are from 26-31 times more likely to develop TB than persons without HIV (2). In parts of sub-Saharan Africa, up to 70% of TB patients are co-infected with HIV (3).

The World Health Organization has endorsed DOTS (Directly Observed Treatment Short-course) strategy of tuberculosis treatment. The DOTS strategy focuses on five main points of action, including government commitment to control TB, diagnosis based on sputum-smear microscopy tests done on suspected TB cases, direct observation short-course chemotherapy treatments, a definite supply of drugs, and standardized reporting and recording of cases and treatment outcomes. The DOTS aim to detect TB as early as possible and treat properly in order to limit transmission in the first place. The WHO advises that all TB patients should have at least the first two months of their therapy observed and preferably the whole of it observed: this means an independent observer watching tuberculosis patients swallow their anti-TB therapy. The independent observer can be a healthcare worker or anyone similar senior person within that society. There are many reasons why patients fail to take their medication. The symptoms of TB commonly resolve within a few weeks of starting TB treatment and many patients then lose motivation to continue taking their medication. Regular follow-up is important to check on compliance and to identify any problems patients are having with their medication. TB treatment requires longer periods of treatment (around 6 months) to entirely eliminate mycobacteria from the body (1).

Primary TB drug resistance occurs in persons who are infected with a resistant strain of TB. A patient with fully susceptible TB develops secondary resistance (acquired resistance) during TB therapy because of inadequate treatment, not taking the prescribed regimen appropriately, or using low quality medication. Drug resistant tuberculosis is transmitted in the same way as regular TB. Drug-resistant TB is a major public health problem in many developing countries, as treatment is longer and requires more expensive drugs. Multi-drug-resistant tuberculosis (MDR-TB) is defined as resistance to the two most effective first-line TB drugs: RIF and INH. The choices of second line drugs for TB are Amikacin (AK), Cipofloxacin (CIP), Ofloxacin (OFL) Moxifloxacin (MFX) Ethionamide (ETD), Capreomycin (CAP), Kanamycin (KAN), *p*-aminosalicylic acid (PAS) and Cycloserine (CYC) (4).

In PNG, TB situation is at a “high burden” as defined by WHO Western Pacific Region (WPR). Due to the lack of active case detection, the current estimate of TB prevalence in PNG is based purely on the records of numbers of TB patients admitted and received treatments. Considering the limited access to health centers in many areas due to difficult terrain, poor to non-existent road infrastructure, lack of laboratory diagnosis and poor overall reporting, the reported TB cases, and hence, the calculated prevalence rate is quite likely to be a significant underestimate of the true burden of TB in PNG. The paucity of accurate data on TB prevalence and incidence, treatment seeking and the extent of drug resistance greatly hamper the efforts to implement an effective DOTS program for the control of TB in PNG. A survey by PNGIMR showed the existing health system detected only 20% of new TB cases and 40% had never sought any form of health care prior the survey (Phuanukoonnon et al, in prep). Hence, there is likely a large pool of un-detected TB cases. Therefore, in order for the national TB control programme in PNG to achieve the international (WHO) 70% case detection standard under DOTS program, the PNG control programme will clearly need to integrate active case detection (ACD) into the overall TB national control program.

As the majority of PNG population (>80%) lives in rural areas with often-difficult access to major health facilities, the national TB/DOTS program is unlikely to have reached the majority of rural populations in PNG. In addition, in some areas of PNG, particularly peri-urban and urban settings, TB co-infection with HIV is a potentially significant concern. Therefore, the underlying TB prevalence

rates are likely to be quite variable based on geography, i.e., rural versus more urban settings. Given this overall context, and using the established integrated health and demographic surveillance sites (iHDSS) sponsored by the Partnership in Health Project (PiHP), PNGIMR developed a series of studies across four different PNG locations in order to develop accurate and objective data regarding the actual burden of TB illness in PNG.

The Partnership in Health Project is a public-private partnership between ExxonMobil PNG Ltd and the PNG Institute of Medical Research (PNGIMR) in order to monitor the potential positive and negative potential health impacts associated with the PNG LNG Project. This TB study is one of the sub-studies under the PiH project. Target locations where there have been both large construction activity and future long-term operations were selected. An iHDSS coastal comparison location (Karkar Island) was also studied.

The TB study sites included, (i) Kikori district, Gulf Province, often known as a "Capital City of TB"; (ii) Hiri West, Central Province, located near the major PNG LNG production facility, (iii) Hides, Hela Province and (iv) Karkar Island, Madang Province. Kikori was a temporary but active PNG LNG construction area site. Hiri and Hides were active during construction and continue to be critical operations and production locations. IMR studied both local health care facilities and the communities serviced by these clinics. If TB illness was detected, patients were referred and treated according to the PNG standard TB treatment Guideline. Under this IMR research protocol, the communities would directly benefit from the research project. TB diagnosis will be provided at the health centre level including treatment. Patients who take their TB treatment in an irregular and unreliable way are at greatly increased risk of treatment failure, relapse and the development of drug-resistant TB strains, so as part of the research strategy, TB patients will be followed-up in order to ensure their satisfactory recovery from the illness.

14.4 OBJECTIVES

1. **To develop TB surveillance system in health facilities in study areas**
    - **a.** To determine the burden of TB illness and drug resistance
    - **b.** To obtain the epidemiological data for all patients, including demographic data, history of TB in the family and contact to TB.
    - **c.** To investigate the level of knowledge of community members on TB

2. **To determine the treatment outcome of TB treatment**
    - **a.** To observe the improvement of TB clinical symptoms and side effect of the treatment
    - **b.** To determine the treatment outcome.

3. **To develop TB laboratory capacity in IMR/TB lab at UPNG, Port Moresby; Kikori hospital; and Paramedical building, DWU, Madang.**
    - **a.** To set up laboratory for TB that will be able to conduct these lab tests:
        - **i.** Microscopy (AFB, Fluorescence microscopy)
        - **ii.** Gene-Xpert
        - **iii.** Preparing for Culture (MGIT 960 system)
    - **b.** To train local laboratory scientists and technicians to perform required lab works

b. To develop lab procedures complied with Quality Assurance standard (QA)
c. To develop the SOP for sample transportation, sample storage and record keeping
d. To support and provide the training for the national laboratory scientists from national institutions (such as DoH, DWU and UPNG)

4. To establish the DOTS with the study participants

a. All study participants will be followed-up
b. Evaluate the challenge of DOTS delivery for further intervention

14.5 STUDY SETTINGS

14.5.1 Kikori district

Kikori is a town located in the Kikori district of the Gulf province of Papua New Guinea. The district is divided into 4 rural local level governments (LLG): West Kikori LLG, East Kikori LLG, Baimaru LLG and Ihu LLG. Kikori district encompasses an area of 27000 km^2, only 2500 km^2 of which is inhabited by a network of villages scattered along a river delta system [5].

There are two hospitals in the Kikori district. Kikori hospital primarily services West Kikori and East Kikori LLGs although a few patients from Baimaru LLG also attend the hospital. Kikori hospital is a 90-bed hospital administered and operated by the Christian charity organization called Gulf Christian Services. There are 25 medical staff at Kikori hospital and volunteer expatriate physicians sporadically visit the hospital. Over the study period, two Australian physicians collaborators attended the hospital to assist with clinical care and data collection. Kikori hospital resident staff manages TB diagnosis, treatment and care. Standard care for TB patients at Kikori generally involves hospital admission, where possible, for the first 2-months of intensive phase treatment followed by 4 months of treatment at home. TB patients are provided with hospital appointments or are referred to nearby health facilities for treatment follow-up. DOTS (directly observed treatment, short-course) intervention had not been implemented at Kikori during the study period. The Kikori district health office TB control program was responsible for TB patient follow-up, but due to funding and manpower issues, the program was not functioning. Accessibility to Kikori town and Kikori hospital is poor.

14.5.2 Hiri integrated Health and Demography Surveillance Site (Hiri iHDSS)

The iHDSS covers four villages in Hiri West, Porebada, Boera, Papa and Lealea. Of these four villages, three are Motuan and one, Papa, is Koita (who are referred to as Koitabu by the Motu). The population distribution, structure and characteristics of Hiri iHDSS are presented in the PiH Scientific Reports (6, 7, 8). Based on the iHDSS morbidity and mortality study (previously reported by PNGIMR), the most common cause of death in the Hiri West iHDSS between 2010 and 2012 was TB (6).

The four Hiri villages have been affected by their proximity to Port Moresby (40 minutes by public transports) and traditional skills in fishing, gardening and other areas have been eroded (9). The PNG LNG Plant site is located in close proximity of these four villages (within 5 Km); hence, the villages are considered to be “impact areas.”

PiH project has established TB passive case detection surveillance at Papa Clinic beginning in July 2012. The Salvation Army (SA) operates Papa Clinic; however, PNGIMR has a formal cooperating agreement with the SA that allows for active participation by IMR researchers. By mid-2011, the IMR TB surveillance expanded and includes both the Boera Aid Post and Porebada Clinic. Both Porebada Clinic and the Boera Aid Post are operated by the Hiri provincial health service. PNGIMR has recruited 1 physician (who also oversees the morbidity surveillance), 1 HEO and 1 community health worker (CHW) in order to run the TB surveillance at the three clinics.

TB patients in Hiri iHDSS are registered at the Papa clinic and get the treatment either from the clinic or from nearby facilities in Port Moresby. Most TB patients started their treatment from home; however, hospital admission to the Port Moresby General Hospital is triggered by either compromised clinical condition or documentation of multiple drug resistance. The TB study team has followed-up those patients at home under DOTS intervention.

14.5.3 Karkar integrated Health and Demography Surveillance Site (Karkar iHDSS)

Karkar iHDSS is located on Karkar Island, a volcanic island located 30km off the PNG coast in the Bismarck Sea and is part of Madang Province. Inhabitants of the island come from one of two language groups; Waskia in the North half of the island and Taskia in the South. Most inhabitants are either Lutheran or Catholic. One main road runs around the coast of the island and provides access to the three available health facilities.

The island's soil is known for its fertility and large plantations produce the island's main exports of cocoa and coconut and provide significant employment opportunities. The Karkar iHDSS covers a sample of about 20,000 out of the total island population of about 60,000. Target recruitment goals were achieved using random cluster sampling in order to select villages weighted by size. The population distribution, structure and characteristics of Karkar iHDSS are presented in the PiH Scientific Reports (6, 7, 8). Karkar has been unaffected by the extensive and intensive mining activity and subsequent in-migration and rapid economic development that has occurred in Madang; hence, Karkar was felt to be an appropriate “coastal control/comparison community” that could be compared to Hiri iHDSS.

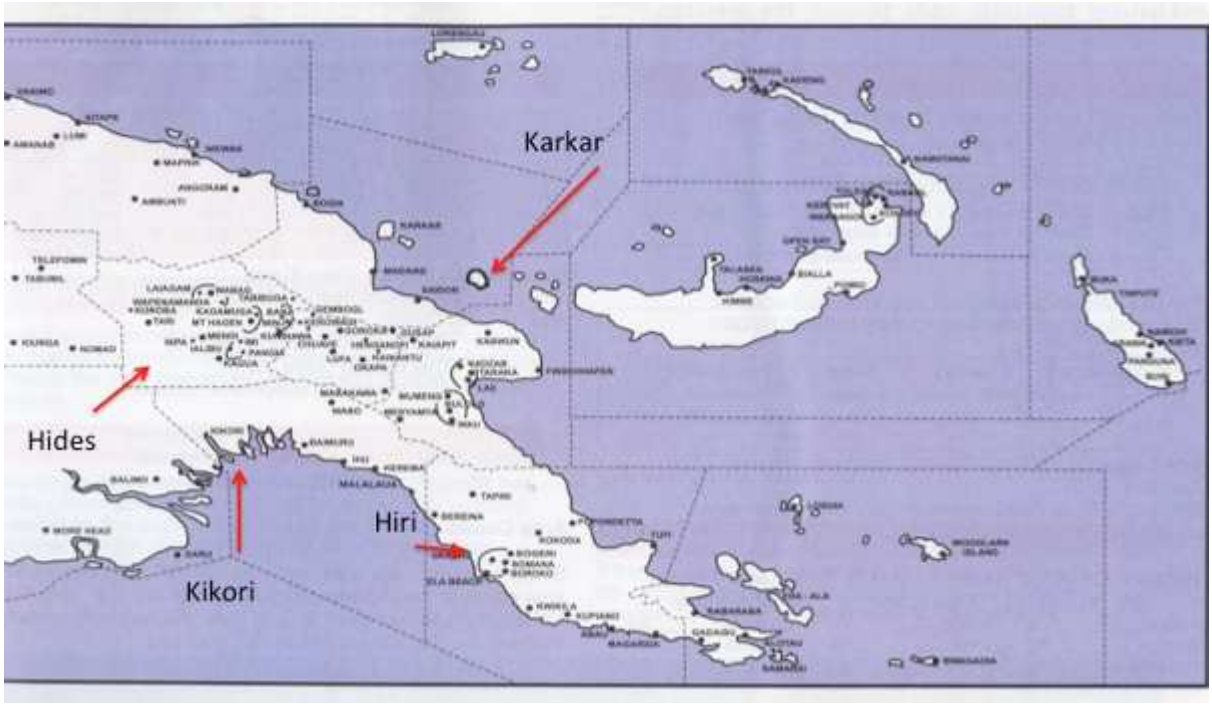
The PiH project has set up the morbidity surveillance at Gaubin Hospital, a Lutheran run institution that is the largest of the available facilities. TB is one of the defined “surveillance diseases” that the hospital monitors. TB surveillance staff includes 1 physician, 1 nursing officer and 1 CHW The IMR/TB lab is located at the Madang Paramedical Building of Divine World University. This facility tests all TB samples from Karkar iHDSS (AFB microscopy and GeneXpert). A medical technologist and a scientific graduate and 1 lab technician oversee the lab.

14.5.4 Hides integrated Health and Demography Surveillance Site (Hides iHDSS)

Hides iHDSS is located in the Hela Province (previously a part of Southern Highland Province). Geographically the area is very remote and rugged. Cultural norms and practices are still an integral part of the locals’ lives. People still live in clans and sub-clans, and maintain a traditional lifestyle. Most of the houses are traditionally built with very few semi-permanent buildings. The main *tokples* language spoken is Huli which is also the common name given to people from that region. Other

languages include pidgin and a rare percentage of English speakers. The main health facilities are Mananda Health Centre and Para Clinic that is run by the Evangelical Church of PNG (ECPNG). However, suspected TB cases are typically referred to Tari hospital for diagnosis and treatment. The Hides PiH TB project has been conducted in the Kikiria Division from August to November 2014. The rational for the TB study was to evaluate the TB burden around the PNG LNG project Hides Gas Conditioning Plant (HGCP). The HGCP is a major long-term production facility. The area near the HGCP was heavily involved in PNG LNG construction activities including development of a major airfield.

Figure 14-1. Map of locations of TB study



14.5.5 Study approval

The Medical Research Advisory Committees granted the approval (MRAC, No. 10/17). We informed the Provincial Health advisors in every location and the community leaders at each study location. Informed consent was obtained from participants prior to sputum collection and interviews. Results of AFB tests and GeneXpert were made available to all participants who submitted the specimens. Participants with positive results were referred to nearby health facilities for registering and initiating TB treatment.

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CHAPTER 1. TUBERCULOSIS IN KIKORI: BURDEN OF TB FROM PERSPECTIVE HOSPITAL BASED STUDY

INTRODUCTION

On a global scale, a substantial proportion of the morbidity and mortality caused by tuberculosis (TB) is attributed to HIV co-infection and the emergence of drug resistance [1]. These factors and their impact on TB incidence and outcomes have been well studied in many African countries [2-4]. The incidence of TB in countries with geographically isolated communities such as Papua New Guinea (PNG) is largely unknown and there is very limited data on drug resistance and HIV co-infection in remote PNG communities. The World Health Organization (WHO) reported annual national incidence of TB in PNG is 346 per 100,000 population and the reported percentage of tested TB patients that are HIV positive is 11% [5]. Due to the geographical isolation of most rural areas and limited access to health care facilities in these areas, the national figure may not reflect true TB incidence in the many remote regions of PNG. It is important to quantify TB incidence in these areas as many resource development projects are opening access to these remote communities and modeling studies performed in the Western province of PNG (adjacent to the Gulf province) have indicated that areas with high disease burden can dominate the TB dynamics of an entire region [6]. Based on work performed and reported in the pre-project health impact assessment, the PNG LNG Project raised concerns that TB was rampant in the Kikori area. Therefore, with PNG LNG Project funding, IMR sought to determine the incidence of TB, the frequency of drug resistance and the incidence of concurrent HIV infection in Kikori.

MATERIAL AND METHODS

Study design

Between March 2012 and June 2012, PNGIMR conducted an observational study to determine the incidence of TB and disease characteristics in Kikori. Patients self-presenting to Kikori District Hospital with TB symptoms and inpatients receiving TB treatment during the study period were invited to participate in the study. Written informed consent was obtained prior to study enrolment. The PNG Medical Research Advisory Committee approved the study (amendment to MRAC No. 10.17) and maintains records of all signed consent forms.

Diagnosis of TB

Three sputum samples were collected from patients with a productive cough. Ziehl-Neelsen (ZN) stains were performed on sputum and other clinical specimens by trained scientists. Aliquots of sputum specimens were frozen and stored at -20 •C for later analysis as described below. Attempts were made to obtain other clinical specimens for ZN smears; this included aspirates from lymph nodes, swabs from discharging ears and aspirates from other collections of pus. The WHO recommended algorithm for the diagnosis of TB, incorporating the international standards for TB care, were used for the diagnosis of TB in this study [7].

Definition of TB cases and new and previously treated cases

The patients enrolled were classified as TB suspects or cases of TB in accordance with the WHO TB Treatment guidelines [8]. A **'**TBsuspect' was defined as a patient with symptoms or signs of pulmonary or extra pulmonary TB and/or constitutional symptoms (loss of appetite, weight loss, fever and fatigue). A 'TB case' was defined as a patient with acid fast bacilli (AFB) detected in ZN stained sputum (or other) specimen, or in the absence of such laboratory confirmation, when a health worker or clinician diagnosed TB based on symptoms and signs and decided to treat the patient with a full course of TB therapy. Cases of TB were further classified as new or previously treated cases [8].

Estimation of population size and TB incidence

Detailed population figures for each province in PNG are available from the 2000 PNG National census. The population serviced by Kikori Hospital in 2000 was 17,779 people. This is the sum of the population in West Kikori rural ward (n=7579), East Kikori rural ward (n=8788) and people residing in Baimaru Station in Baimaru rural ward (n=1416). The annual population growth rate from the most recent census in 2011 is known to be 1.2%, however absolute population figures have not yet been made available. Therefore the population serviced by Kikori Hospital in 2012 is estimated to be 20,144 people.

HIV testing

HIV testing was performed using the Alere Determine HIV-1/2 Ag/Ab Combo Rapid test kit HIV 1/2 119 STAT-PAK, Chembio Diagnostic Systems (NY, USA), after patients received appropriate provider-initiated HIV counseling and testing (PICT).

GeneXpert testing, microscopy culture and genotyping

Each sputum sample was analysed by two trained microscopists for AFB at Kikori Hospital. Aliquots of all sputum samples obtained from cases were frozen and stored at -20□C for several months before being sent to the PNG Institute of Medical Research (Madang) or the Queensland Mycobacterial Reference Laboratory (QMLR) in Australia for GeneXpert assays.

Sputum samples were decontaminated according to Petroff's method [9] and GeneXpert assays utilizing the Xpert MTB/RIF kit (Cepheid, Sunnyvale California USA) were performed as described previously [10]. Additionally, Queensland MLR cultured all AFB smear positive sputa using BACTEC^{TM}MGIT^{TM} (Beckton Dickinson, USA) and performed drug susceptibility testing (DST) and genotyping analyses on all isolates that were recovered after culture. DST was performed by the proportion method [11] using BACTEC^{TM}MGIT^{TM} 960 [12].

DNA was purified from cultures using ethanol and heating to 95^{o}C and multilocus mycobacterial interspersed repetitive unit variable number of tandem repeats (MIRU-VNTR) was used for molecular analysis and to define strains as previously described using GenoScreen (Lille Cedex, France) MIRU-VNTR Typing Kit – *Mycobacterium tuberculosis* Complex 24-loci [13]. Amplified products were detected using the AB$^{®}$ 3130x1 genetic analyser with GeneScan^{TM} 1200 LIZ$^{®}$ size standard (Appliedbiosystems, Life Technologies, NY, USA). The results were analysed using GeneMapper$^{®}$ Solfware (Appliedbiosystems, Life Technologies, NY, USA).

The online MIRU-VNTRplus tool (http://www.miru-vntrplus.org) was used to calculate a neighbor-joining tree using categorical distance measures based on 24 loci MIRU-VNTR, and to represent strains and lineage similarities as previously described [14, 15]. The loci (and corresponding aliases) used in our studies were: 154 MIRU02, 424 Mtub04, 577 ETRC, 580 MIRU04 ETRD, 802 MIRU40, 960 MIRU10, 1644 MIRU16, 1955 Mtub21, 2059 MIRU20, 2163b ^{QUB11b}, 2165 ETRA, 2347 Mtub29, 2401 Mtub30, 2461 ETRB, 2531 MIRU23, 2687 MIRU24, 2996 MIRU26, 3007 MIRU27 QUB5, 3171 Mtub34, 3192 MIRU31 ETRE, 3690 Mtub 39, 4052 QUB26, 4156 QUB4156 and 4348 MIRU39. It is noted that the laboratory work has taken at least 10 months to get a complete data on the genotyping, and TB drug resistance testing (DST) is still on going at the QMRL.

Data collection and data entry

Data were collected through patient interview for all TB cases, and stored in a dedicated database. Data entry was done using FileMaker pro 11 (Filemaker Inc, Santa Clara, CA) database.

Demographic variables

The following demographic variables were recorded for each patient: age, gender, body mass index (BMI), occupation, level of education, access to mobile phone, distance from hospital, smoking status, alcohol consumption, exposure to in-house smoke and chewing of betel nut. BMI for children and teenagers was calculated using the Centers for Disease Control and Prevention BMI online calculator tool (http://apps.nccd.cdc.gov/dnpabmi/). Exposure to smoke from cooking fires has been associated with an increased risk of TB [16], and spitting associated with betel nut chewing may facilitate transmission of infection in crowded housing [17]. Another variable captured was ethnicity (Papuans and Highlanders), to ascertain the ethic representation amongst TB cases.

Risk factors for TB

The following potential risk factors for TB were recorded for each patient: contact with a TB case, history of previousTB treatment, crowding (number of people in cohabitation), and absence of a BCG vaccination scar.

Distribution of TB cases

Global Positioning System (GPS) coordinates for the homes and villages of 143 TB cases were ascertained by visiting the villages and using a Garmin eTrex 10 GPS device. GPS coordinates were plotted using Epi Info 7 software (Center for Disease Control USA).

Time trends in TB incidence in Kikori

Hospital records of the National TB Register from 2004 to 2012 were reviewed to obtain the number of patients commenced on TB therapy every year.

Statistical analysis

Statistical analysis was performed with STATA software version 12 (STATA Corp, College Station, TX). Confidence intervals for TB incidence were calculated using both the Wilson score interval and Agresti-Coull adjusted Wald interval methods.

RESULTS

Patient characteristics

Two hundred and eighty seven people were approached for informed consent. Thirteen declined consent and 274 were enrolled into the study. Of the 274 patients enrolled; 146 were determined to be TB cases and 128 were TB suspects (Fig. 2.1). Seventy-four of the 146 cases had sputum or other clinical specimens collected. In the remaining 72 cases we were unable to collect adequate specimens for analysis. Sputum and clinical specimens from 44 of the 74 cases were AFB positive or had MTB DNA detected by GeneXpert (Table 1.1). The demographic characteristics of TB cases are detailed in Table 1.2.

Table 1.2. Specimen results for 146 patients

Test and result	Number
ZN stain for AFB	
Clinical specimen not available	71
Sputum available for ZN stain	70
Negative	36
Positive	34
Scanty (1-9 AFB /100 fields)	3
1+ (10-99 AFB/100 fields)	2
2+ (1-10 AFB/ field)	13
3+ (> 10 AFB / field)	16
Other clinical specimens	5
Negative (ear swab)	1
Positive	4
Lymph node aspirates	*2 (both scanty)
Ear swab	1 (3+)
Aspirate from abscess	1 (1+)
Xpert MTB/RIF	
Sputum available for GeneXpert	67** (33 AFB+ve, 34 AFB -ve)
MTB not detected	30 (3 AFB +ve, 27 AFB -ve)
MTB detected	37 (30 AFB +ve, 7 AFB -ve*)
High	14 (all AFB +ve)
Medium	8 (all AFB +ve)
Low	(10 6 AFB +ve, 4 AFB -ve)
Very Low	5 (2 AFB +ve, 3 AFB -ve)
rpOb mutation (rifampicin resistance) detected	3 (all AFB +ve)

*One patient had a ZN negative but GeneXpert positive sputum along with a ZN positive lymph node aspirate

** Three sputum specimens were lost and not available for GeneXpert testing

The median age of TB cases was 22 years and 36% of all TB cases were under the age of 16 years. Fifty eight percent of cases had had no formal education or had only completed primary school education. Of note, 62% of cases had access to functional mobile phones. Twenty percent of patients had to travel for more than one day to get to the hospital. Most patients were non-smokers but 71% had exposure to in-house smoke from cooking fires. Potential risk factors for TB in cases are detailed in Table 1.3. Seventy three percent of cases reported having had had contact, usually through co-habitation, with at least one other person that was diagnosed with TB. Many households consisted of more than 10 occupants in a single dwelling.

Table 1.3. Demographic characteristics of 146 TB cases

Characteristics	**N = 146 (%)**
Median age	22 (range: 8 months to 76 years)
Age	
< 5 years old	25 (17%)
5 – 15 years old	27 (18%)
16 – 59 years old	90 (62%)
≥ 60 years old	4 (3%)
Sex	
Male	66 (45%)
Female	80 (55%)
Ethnicity	
Papuan	141 (97%)
Highlanders	5 (3%)
Occupation	
Subsistence Farmers	65 (44%)
Students	41 (28%)
Mining Industry	15 (10%)
Health Workers	3 (2%)
Children/ Unknown	40 (27%)
Level of education	
University education	1 (0.7%)
Diploma	2 (1.4%)
Trade School	2 (1.4%)
High School education	23 (15.8%)
Primary school education	51 (34.9%)
No formal education	33 (22.6%)
Unknown/ Children under school age	34 (23.2%)
Mobile phone access	
NO access to mobile phone/ no coverage	55 (37.7%)
Access to own mobile phone	51 (34.9%)
Access to family members mobile phone	40 (27.4%)
Distance from hospital	
Walk ≤ 1 hour	46 (31.5%)
Boat Road trip ≤ 1 hour	29 (20%)
Walk > 1 hour < 1 day	0
Boat Road trip > 1 hour < 1 day	44 (30%)
Walk ≥ 1 day	5 (3.4%)

Characteristics	**N = 146 (%)**
Boat/ Road trip ≥ 1 day	22 (15.1%)
Smoking status*	
Non smokers	104 (71.2%)
Smokers	41 (28.1%)
Unknown	1 (0.7%)
Exposure to in-house smoke**	
Exposed	104 (71.2%)
No Exposure	32 (21.9%)
Unknown	10 (6.9%)
Alcohol consumption	
Drink Alcohol	30 (20.5%)
Never Drink Alcohol	115 (78.8%)
Unknown	1 (0.7%)
Betel nut chewing	
Does not chew betel nut	92 (63%)
Chews betel nut	53 (36.3%)
Unknown	1 (0.7%)

*Actively smoking any quantity of cigarettes prior to and leading up to illness

** Any exposure to wood smoke from in-house fire prior to and leading up to illness

Table 1.4 Potential risk factors for TB in 146 TB patients

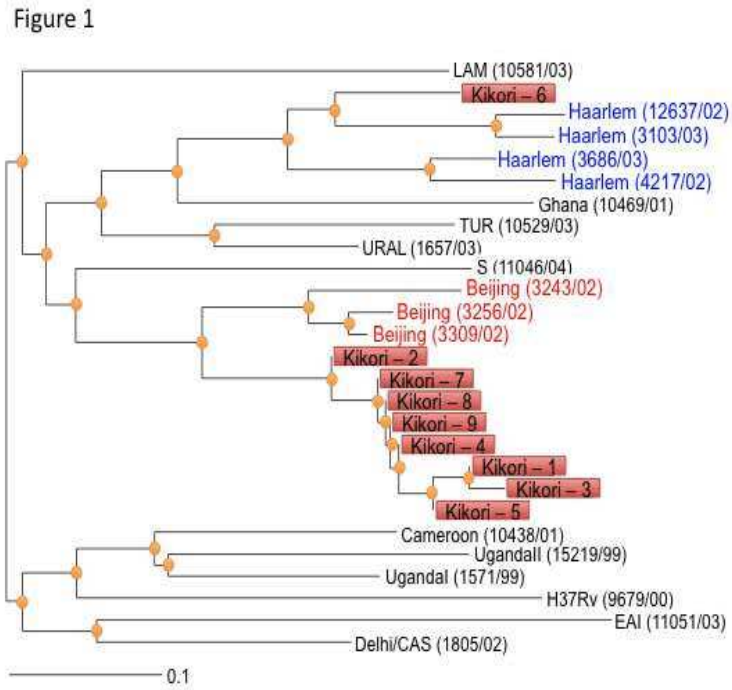
Risk factors	**Frequency (%)**
Contact with TB case	107 (73.3%)
No contact with TB	34 (23.3%)
Unknown	5 (3.4%)
Number of people in a household	
≤ 5	35 (24.0%)
6 – 10	71 (48.6%)
> 10	40 (27.4%)
History of TB illness	
No history of TB	99 (67.8%)
Unknown	1 (0.7%)
History of previously treated TB	46 (31.5%)
Relapsed case	11/46 (23.9%)
Treatment failure	6/46 (13.1%)
Defaulted on therapy	18/46 (39.1%)
Completed treatment but uncertain if symptoms resolved	11/46 (23.9%)
BCG scar	
BCG scar present	99 (67.8%)
No BCG scar	41 (28.1%)
Unknown	6 (4.1%)

Microbiology

All sputum and clinical specimens, obtained from cases, were ZN-stained and the number of AFB was quantified (Table 1.1). Eighty five percent of AFB positive sputa (29/34) had a heavy burden of bacilli (2+ or 3+). IMR analyzed 67 out of 70 sputum samples (3 were lost) with GeneXpert for the presence of Mycobacterium *tuberculosis* (MTB) DNA and rifampicin resistance (*rpoB* gene mutation) [10, 11]. Thirty of the 34 smear positive sputa had MTB DNA detected by GeneXpert and three of these had rifampicin resistance detected. MTB DNA was also detected in 7 out of 36 AFB smear negative specimens obtained from TB cases, and none of these were rifampicin resistant on GeneXpert analysis (Table 1.1).

There was a wide geographical distribution of TB cases (Appendix 1) and rifampicin resistant isolates across the region. One out of the three patients with rifampicin resistance had previously been treated for TB and had defaulted on therapy. The other 2 patients had no history of TB treatment. MTB DNA was detected by GeneXpert in 7 of the 34 AFB smear negative sputum specimens obtained from TB cases and available for testing (Table 1.1). All sputum specimens that were AFB positive were cultured and 10 specimens yielded isolates. DST confirmed that all of the cultured isolates were sensitive to first line drugs. Genotypic profiling was performed on these isolates using MIRU-VNTR. A complete pattern was only available for 9 isolates from cases distributed across the Kikori region. Most isolates resembled Beijing strains and allelic diversity was noted at two loci (Figure 1.1).

Figure 1.1. Phylogentic tree of 9 cultured isolates from Kikori. Numbers in parentheses represent MIRU-VNTRplus database strain ID numbers.



TB clinical manifestations and treatment follow-up

A complete summary of clinical symptoms and signs for TB cases is shown in Table 2.1. Thirty four percent of children were severely underweight with BMIs falling below the 1st percentile. The clinical focus or site of TB in cases is shown in Table 2.4.

Table 1.4. TB in 146 cases by site

TB site	N of patients	Positive ZN smear	Median age
Disseminated TB	14 (9.6%)	1 sputum	7 (1 – 35)
		1 ear swab	
		1 lymph node aspirate	
Pulmonary TB	72 (49.3%)	34 sputa	30 (< 1 – 76)
		(+ 7 AFB –ve but GeneXpert +ve)	
TB Lymphadenitis	28 (19.2%)	1 aspirate	10 (< 1 – 40)
TB Abdomen/ Pelvis	11 (7.5%)		19 (2 – 45)
	6 (4.1%)		4 (2 – 5)
TB Malnutrition	6 (4.1%)		3.5 (< 1 – 5)
TB Spine	3 (2.1%)	1 aspirate	25 (8 – 47)
TB in Joint	1 (0.7%)		6
Sites Unknown	5 (3.4%)		28 (24 – 56)

IMR next assessed factors that may be contributing to the development of TB and its management. HIV screening was performed on 105 TB cases. IMR identified 2 TB cases that were co-infected with HIV (1.9%). IMR collected data on patient management, discharge and follow-up. By the end of the study, 37 of 146 cases (25%) were inpatients, 17 (12%) were being managed as outpatients and 7 (5%) were transferred to another hospital closer to their home village or to mining camp clinics if employed by the mining sector. Sixteen cases (11%) defaulted on their therapy during the course of the study with the most common reason being a lack of food provision at the hospital (7/16). The remaining cases (46%) were discharged to their home with a supply of TB medication because of hospital bed shortages. Two cases (1.4%) died during the study period but formal mortality rates could not be calculated, as many cases were lost to follow-up after hospital discharge. Only 24 of 83 cases (29%) that were discharged from hospital, with TB therapy, attended any follow-up appointment.

Incidence of TB in Kikori

Over the course of the study period, the number of TB cases enrolled per month remained consistent, ranging from 20 to 33 per month. To estimate TB incidence IMR only included cases that were diagnosed and commenced on treatment during the study period (n=97). Based on the number of new, relapse and re-infection cases (Fig. 2.3) over 16 weeks, IMR extrapolated the TB incidence to be 1,130 cases per 100,000 people, per year (95% CI: 1000 to 1300 per 100,000) in the Kikori region (West and East Kikori LLGs and Baimaru Station in the Baimaru LLG). IMR next assessed if the large number of TB cases was a recent or more chronic problem. IMR reviewed hospital records to track

the number of registered TB cases at Kikori Hospital between 2004–2011. The number of expected 10 cases for 2012 based on extrapolated figures from our 16-week study is 315, and this is consistent with figures over the preceding 8 years. Table 2.5 showed the Global incidence rate of TB. The rate in Kikori is much higher than the estimated rate for PNG.

Figure 1.2. Flow chart for calculating incidence of TB in Kikori

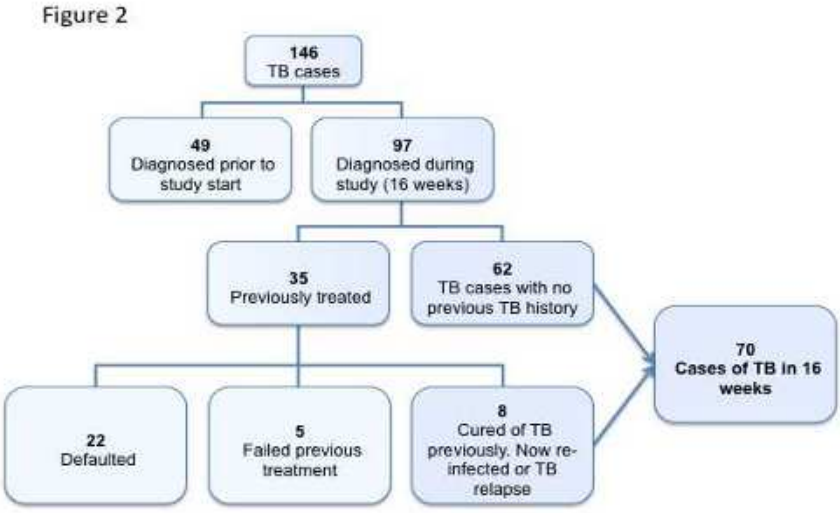


Table 1.5. Global Incidence of TB

Country	Per 100, 000 pop
Swaziland	1287
South Africa	981
Timor-Leste	498
D. Republic of Congo	327
Papua New Guinea	303
Kikori	**1130**
Indonesia	189
India	185
Russian federation	106
China	80
Australia	6.3

Source: WHO, Global Tuberculosis Report, 2011

DISCUSSION

IMR has confirmed the concerns raised by the PNG LNG Project and have identified ***one of the highest TB incidence rates in the world***, [5] much higher than the WHO figure reported in 2011 [18]. IMR used the same case definitions in our study that are used by the PNG government in reporting national incidence to WHO. The IMR incidence figure may be an underestimate of the true incidence, as only patients presenting to the hospital were included in the study and we did not perform active case finding in the community villages. The incidence reported by IMR is not a temporally isolated event coincident with our study, as a review of Kikori Hospital TB registries indicates that TB has been problematic in the area since at least 2004. In contrast to the high TB incidence rates reported in African countries [19], the rate in Kikori is unusual as it is not associated with a high frequency of HIV co-infection. Several factors are probably contributing to the high incidence of TB in Kikori including: delayed presentation, difficulties in managing patient follow-up, infectious burden, and the interplay between local environmental factors and immunity. The IMR analysis of case demographics, disease characteristics and microbial genetics sheds some light on the likely factors that contributes to the Kikori TB incidence.

Delayed presentation is evident in the IMR study as illustrated by the number of complicated presentations including disseminated TB, and the duration of symptoms. IMR found literacy to be poor and in the absence of education, cultural beliefs and folklore can delay the seeking of early treatment for TB [20]. Additionally the remoteness of some villages precluded early access to medical care and compromised treatment and follow-up. Access to medical care and follow-up could potentially be improved by contacting patients that return home using mobile phone. The remoteness of the hospital from major drug distribution centers also complicated supply of both loose and fixed combination anti-TB drugs. The late presentation of cases and the inefficiencies in treatment access and delivery may contribute to prolonged transmission risk and very high infectious burdens of MTB. The IMR study highlights that overcrowding, spitting as a cultural phenomenon, and the heavy AFB density in most cases, could translate to a high infectious load which results in a cycle of infection, repeated exposure, onset of clinical disease, and further transmission of disease. Drivers of clinical disease in Kikori might include malnutrition and exposure to household smoke [21, 22].

IMR's ability to culture specimens and obtain isolates for genotyping and other analyses was compromised by difficulties in maintaining a cold chain during storage and transport. Culture recovery rates in the Australian reference laboratory were low, although the Xpert MTB/RIF assay performed well on smear positive samples despite the loss of viability. Of the ten isolates grown and drug susceptibility completed, all were pan susceptible to the five first line agents, including pyrazinamide. IMR were not able to recover culture isolates form the three sputa that were found to harbour *rpoB* mutations. While rifampicin resistance is considered a strong predictor of multidrug resistant phenotype [23, 24], the association is not invariable [25] and cannot necessarily be inferred in Kikori where no prior knowledge of drug resistance patterns exists. Although sample size is small, the finding of three rifampicin resistant isolates amongst 37 strains tested (8%) is of concern and a systematic study of patterns of drug resistance to anti-tuberculous agents is urgently required in this patient cohort.

Whilst the exact factors driving TB in Kikori are unclear, it would appear that circumstances, such as development of new land-based large industrial projects, could easily trigger an environment for the generation and spread of MDR/TB. This is a major concern for a region that has limited access to, and ability to deliver and monitor second line therapies. In `the absence of substantial improvements in infrastructure and supports, *ad hoc* administration of 12 second line therapy could result in the development of extensively drug resistant TB [26]. The high TB incidence in Kikori could rapidly promote the dominance of resistant TB strains unless a reliable TB control program is implemented that can detect cases, support microbiological diagnosis including rapid detection methods such as Xpert MTB/RIF and ensure treatment adherence and follow-up. The more immediate consequences of the high incidence of TB in Kikori and its impact on morbidity and mortality need to be urgently addressed. The IMR study shows that, in at least one remote region in PNG, there is an extremely high incidence of TB, with the potential to promote the emergence and expansion of MDR/TB.

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Cross G, Cole K, Nikpour M, Moore O, Denholm J, McBryde E, Eisen D, Warigi B, Carter R, Pandey S, Harino P, Siba PM, Coulter C, Mueller I, Phuanukoonnon S, Pellegrini M. TB Incidence and Characteristics in the Remote Gulf Province of Papua New Guinea. BMC Infectious Diseases 2014; 14:93 doi: 10.1186/1471-2334-14-93.

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CHAPTER 2. TUBERCULOSIS TREATMENT COHORT STUDY IN KIKORI

INTRODUCTION

In PNG, the health record keeping at rural health facilities is generally poor and inadequate. Most treatment outcomes of TB patients in registration records are invariably missing or incomplete. Therefore, these data could not be used for evaluation of either TB control performance or DOTS intervention effectiveness. This study is designed to investigate the treatment outcome of TB patients who lived in the catchment of Kikori hospital.

METHODS AND MATERIALS

This research part was conducted from July 2012 to November 2014.

Study design

Patients were suspected of having tuberculosis if they had any of the following symptoms: cough for 2 weeks or more; lost of appetite; weight loss; or night sweats. Upon presentation to the TB clinic at Kikori hospital, suspected TB cases were asked to submit sputum for diagnosis. Once the result of the AFB microscopy and/or GeneXpert indicated TB (details of the laboratory work are presented in Chapter 1), the patients were registered at the TB clinic, and treatment was initiated by the IMR clinicians who were working at the TB clinic. The TB patients who (i) lived in the areas where IMR could follow up by either car or boat and (ii) provided formal consent were enrolled into the study. The follow up was scheduled at 2, 4 and 6 months and 8 months for those with category II treatment. The TB patients who diagnosed through active case detection survey (as detailed in Chapter 3) were enrolled into the cohort study.

Before starting the treatment, all TB patients had a series of lab tests: (i) liver function, (ii) serum electrolytes and (iii) visual testing as TB drug side effects include rash, itching, optic neuropathy, and induced hepatitis. The Department of Health, under Global Fund's support, has provided the first-line treatment to all TB patients free of charge.

TB patients are followed-up in order to monitor their clinical improvement (e.g., vital sign, weight, and increase in apatite), side effect of TB medicines (e.g., orange-colored urine, rash and jaundice, etc.) and checking on DOTS activities with the TB treatment partners including counting the patients' TB pills. The follow-up 6 months was with TB patients under Category I treatment, and 8 months for Category II treatment. The ultimate aim is to completely cure TB illness.

Data collection and data entry

Data were collected through patient interview for all TB cases, and stored in a database. Data entry was done using FileMaker pro 11 (Filemaker Inc, Santa Clara, CA) database.

Demographic variables

For each patient, these data were recorded: age, gender, body mass index (BMI), occupation, level of education, access to mobile phone, distance from hospital, smoking status, alcohol consumption, exposure to in-house smoke and chewing of betel nut. BMI for children and teenagers was calculated using the Centers for Disease Control and Prevention BMI online calculator tool (http://apps.nccd.cdc.gov/dnpabmi/). Another variable captured was ethnicity (Papuans and Highlanders), in order to ascertain the ethic representation amongst TB cases.

Risk factors for TB

The following potential risk factors for TB were recorded for each patient: contact with a TB case, history of previous TB treatment, crowding (number of people in cohabitation), and absence of a BCG vaccination scar.

Statistical analysis

Statistical analysis was performed with STATA software version 12 (STATA Corp, College Station, TX).

RESULTS

A total of 293 TB cases were enrolled into the Kikori treatment cohorts. Of these 126 (43%) were children < 15 yrs and 167 were adults (Table 2.1) with approximately equal numbers of male (47.1%) and female patients (52.9%). All but 8 patients (2.7%) were local Papuans, the majority of adults were involved in substance farming (95.8%) and only 28 (9.6%) had more than primary school education. 47.4% of patients walked to the hospital, 41.0% were brought by boat while 11.6% came by Public Motor Vehicles (PMV).

Table 2. 1 Demographic characteristic of 293 TB cases

Characteristics	N = 293 (%)
Mean age	22 (range: 4 months to 68 years)
Age	
< 5 years old	41 (14.0%)
5 – 15 years old	85 (29.0%)
16 – 59 years old	155 (52.9%)
≥ 60 years old	12 (4.1%)
Sex	
Male	138 (47.1%)
Female	155 (52.9%)
Ethnicity	
Papuan	285 (97.3%)
Highlanders/Sepik	8 (2.7%)
Occupation	
Subsistence Farmers /no formally employed	166 (56.7%)
Students/children	120 (40.9%)
Formally Employed	7 (2.4%)
Level of education	
University education	1 (0.3%)

Characteristics	N = 293 (%)
High School education	27 (9.3%)
Primary school education	123 (41.9%)
Elementary school education	11 (3.8%)
No formal education	60 (20.5%)
Unknown/ Children under school age	71 (24.2%)
Mobile phone access	
No access to mobile phone/ no coverage	192 (65.5%)
Access to own mobile phone	38 (13.0%)
Access to family members mobile phone	63 (21.5%)
Travel to hospital by	
Walking	139 (47.4%)
Boat (canoe or dinghy)	120 (41.0%)
Public motor vehicles (PMV)	34 (11.6%)
Exposure to in-house smoke	
Exposed	173 (59.0%)
No Exposure	120 (41.0%)
Smoking status*	
Smokers	46 (27.5%)
Non smokers	121 (72.5%)
Alcohol consumption*	
Drink Alcohol	39 (23.4%)
Never Drink Alcohol	128 (76.6%)
Betel nut chewing*	
Chews betel nut	87 (52.1%)
Does not chew betel nut	80 (47.9%)

* Denominator is 167, a total number of participants aged>15 years old

The majority of patients had in-house smoke exposure. Only 12.6% of TB cases lived in a household with 5 or less household members. 57% of household had 6-10 and 30.4% >10 members. Among the adults (n=167), 52.1% chewed betel nut, 27.5% smokes and 23.4% drank alcohol. 34.5% either had a mobile phone or lived in a household that owned at least 1 mobile phone.

Age/sex and PTB versus EPTB for Kikori illustrate in the Figure 2.1 and 2.2. EPTB was a dominant type among children (under 15 years old); EPTB versus PTB case counts was 4 fold (46 vs 11) for female and 7 fold (58 vs 8) for male. Case counts for PTB and EPTB among female adults were similar (42 vs 55), while PTB case number for male adults (50) was two times higher than the number of EPTB (21).

Figure 2.1 Female TB counts by TB type and Age

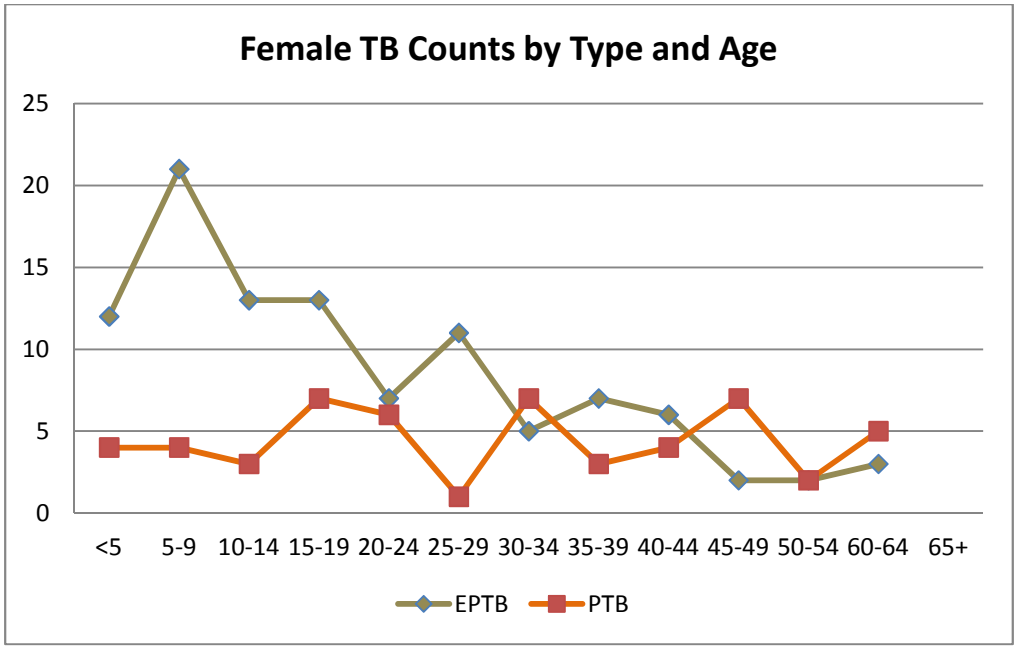
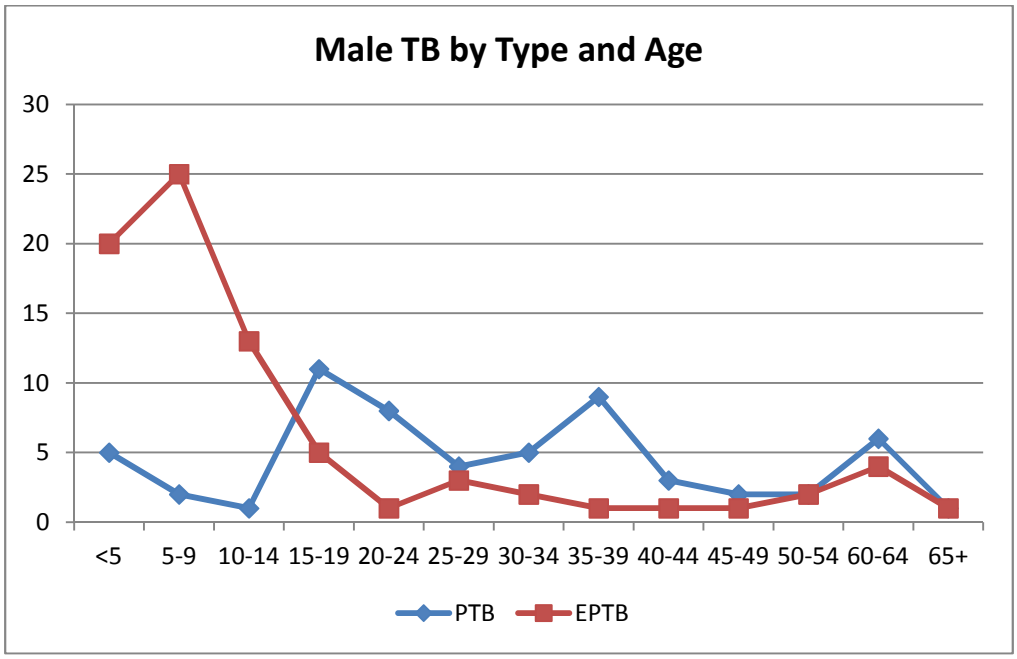


Figure 2.2. Male TB counts by TB type and Age



Three out of 4 TB patients (224, 76.5%) had previous contact with another TB patient. The majority of these contacts were relatives (55.6%, mostly living within the same household), the rest had contact with TB patients in their communities (Table 2.2). Just over half (56.3%) of these contacts had completed treatment and/or were cured, 22.9% were still under treatment, while the rest had died (14.3%), defaulted (2.3%) or failed treatment (4.3%)

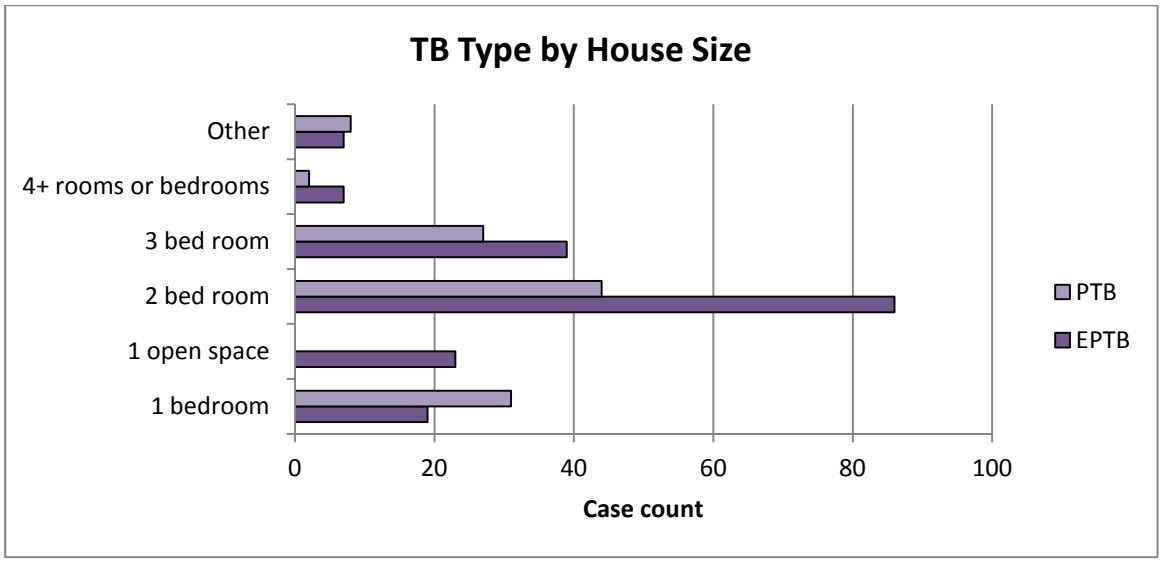
Table 2.2. Potential risk factors for TB in 293 TB patients

Risk factors	**Frequency (%)**
No contact with TB	69 (23.5%)
Contact with TB case	224 (76.5%)
Relationship with "contact" TB cases	
Parents (father or mother)	91 (31.1%)
Children	16 (5.5%)
Relatives	50 (17.0%)
Others (friends and community members)	136 (46.4%)
Treatment outcome of the "contact" TB cases	
Still on treatment	53 (18.1%)
Completed treatment	118 (40.3%)
Cured /resolved	12 (4.1%)
Defaulted	5 (1.7%)
Treatment failure/ chronic	10 (3.4%)
Died	33 (11.3%)
Number of people living in a household	
≤ 5	37 (12.6%)
6 – 10	167 (57.0%)
> 10	89 (30.4%)
History of TB illness	
No history of TB illness	203 (69.3%)
History of previously treated TB	90 (30.7%)
Number of TB episodes	
- *1 episode*	78/90 (86.7%)
Treatment Category I received	78/90 (86.7%)
- *2 episodes*	9/90 (10.0%)
Treatment Category I received	5/90 (5.6%)
Treatment category II received	4/90 (4.4 %)
-*3 episodes*	3/90 (3.3%)
Treatment Category II received	3/90 (3.3%)
BCG scar	
BCG scar present	214 (73.0%)
No BCG scar	79 (27.0%)

90 patients (30.7%) had a previous history of TB illness and of these, 78 (86.7%) had 1 single previous episode, all of whom had received Category I treatment. Twelve patients reported two or three previous episodes. Only 7 of these patients received Category II treatment while 1 reported having Category I treatment. A BCG scar was presented in 73% of all cases.

Eighty seven percent of TB cases lived in crowd household (more than 5 members) and 75 PTB cases lived in a smaller physical house size (1-2 bedroom houses) while 37 cases lived in more than 2 bedroom houses (Table 2.2, Figure 2.3). One third of PTB cases (34 cases) lived with 5 children and more in the same house. Increases in household size without concomitant increases in the household physical setting, and the presence of young children dramatically increase transmission risk.

Figure 2.3. TB types and house size in Kikori



Only 112 (38.6%) of the TB patients had pulmonary TB, and of these 68 (60.7%) were AFB positive (Table 2.3). For the AFB+ patients, 56 (82.4%) had either 2+ or 3+ positive AFB tests (Table 2.4). A total of 93 cases were tested by GeneXpert (66 AFB positive, 27 negative) with 29 (31.2%) returning a MTB positive test. Of the MTB positive cases, 3 (10.3%) were positive *rpOb* mutation indicating rifampicin resistance. Among the 44 AFB negative patients, 7 were GeneXpert positive and 37 were diagnosed clinically and confirmed by chest X-ray.

Table 2.3. TB in 293 cases by site

TB site	N of patients	Positive ZN smear	Mean age (age range)
Pulmonary TB	112 (38.6%)	68 AFB +ve	29 (4 mths – 68 yrs)
		7 AFB –ve GeneXpert +ve	
EPTB	181 (61.4%)		
TB Lymphadenitis	104/180 (57.8%)	4 aspirates (2+ve)	14 (1 – 60 yrs)
TB Abdomen	31/180 (7.5%)		28 (1 – 60 yrs)
HIV test	Reactive 1/171		

* The AFB microscopy and clinical checks were the TB diagnosis methods conducted during the time (around 6

Of the 181 (61.4%) extra-pulmonary TB cases, 104 (57.5%) had lymph node TB while 31 (17.1%) had abdominal TB. The rest of the EPTB cases included meningitis/spinal, joint and disseminated TB. Of the 171 patients (58.4%) who consented for HIV test, only 1 (0.6%) returned a positive test.

Table 2.4. Sputum specimen results for 112 PTB patients

Test and result	Number
ZN stain for AFB	
Sputum available for ZN stain	112
Negative	44
Positive	68
Scanty (1-9 AFB /100 fields)	2
1+ (10-99 AFB/100 fields)	10
2+ (1-10 AFB/ field)	25
3+ (> 10 AFB / field)	31
Xpert MTB/RIF	
Sputum available for GeneXpert	93** (66 AFB+ve, 27 AFB -ve)
MTB detected	29 (7 AFB –ve)
rpOb mutation (rifampicin resistance) detected	3 (all AFB +3ve)

Health seeking behavior

Fifty-four percent of patients reported seeking diagnosis as their own decision while, while 46% were pressured by families to come to the hospital. Prior to presenting at the TB clinic at the Kikori hospital, 150 patients had purchased medicines and self-treated with Amoxycilin (33), Erythomycin (24), Panadol (40), antimalarials (12) or other medicine (41), including traditional bush medicines.

Treatment outcomes

Of the 112 cases of PTB, 35 (31.3%) were confirmed cured and another 58 (51.8%) completed treatment and could no longer produce sputum for final TB testing. Therefore, 83.0% of patients had a satisfactory treatment outcome. Five patients defaulted, 8 were lost to follow-up and 4 transferred out. One patient died and one failed treatment.

Table 2.5. Treatment outcome from these cohort TB patients:

Treatment outcome	Pulmonary TB	Extra Pulmonary TB	Total
Cured	35	5**	41
Defaulted	5	15	20
Died	1	5	6
Lost to follow up	8	20	28
Transferred out	4	0	4
Treatment completed	57*	136**	194
Treatment failure	1	0	1
Total	112	181	293

* Patients completed their treatment, could not produce sputum for the final TB test.

** Based on clinical examination and X-ray

Among the 181 EPTB cases, 77.9% had an appropriate treatment outcome, 19.3% did not completed treatment (15 defaulted, 20 lost-to-follow-up) and 5 died (2.8%). Poor treatment outcomes were most common in patients that had <80% of supervised DOTS treatments (32/33, Table 2.6)

Table 2. 6. Association of treatment outcome with rates of directly observed treatment (DOTS)

Treatment outcome	% Supervised DOTS			No DOTS	Total
	80-100%	50-80%	<50%		
Cured	41	0	0	0	41
Defaulted	4	9	3	4	20
Died	0	3	2	1	6
Lost to follow up	4	2	13	9	28
Transferred out	3	0	0	1	4
Treatment completed	193	1	0	0	194
Chronic	1	0	0	0	1
Total	246	15	18	15	294

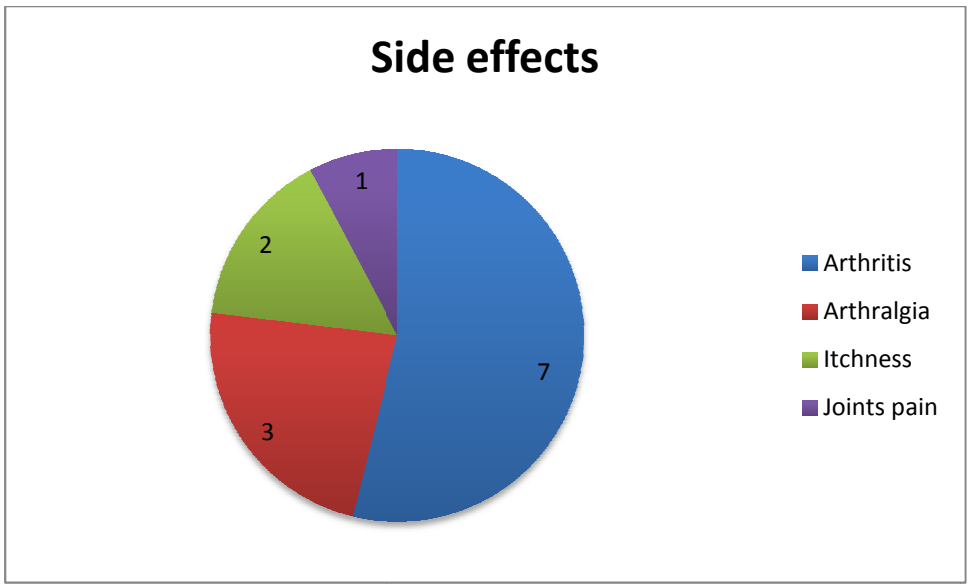
Average Body Mass Index (BMI) of TB patients aged 15 and over had increased from the baseline or at enrolment to the end of intensive phase (2 months) and the end of the continuous phase (6 months for Cat I and 8 months for Cat II) as shown in Table 2.7.

Table 2.7. Body Mass Index before, during and after TB treatment

	BMI average	Range
At enrolment (N=293)	19.3	11.2 to 28.5
At the end of intensive phase (N=90)	20.2	15.0 to 27.1
At the end of continuous phase (N=148)	20.6	15.4 to 26.3

There was no serious side effect reported in the cohort study. Common side effects observed in this cohort were arthritis, arthralgia, itchiness and joints pain (Figure 2.4).

Figure 2.4: Most commonly reported side effects of TB treatment



DISCUSSION

Key risk factors for TB in Kikori included household density and BCG status (1). The burden of TB and its transmission in this remote community was high as three quarter of participants had previous contact or lived with another TB patient. One third had a previous history of TB illness and at least one prior active episode. Over 80% of PTB cases had AFB results of 2 or 3+ at their first visit at the enrolment, which indicated the high infectivity among PTB patients.

GeneXpert testing is critical, as it detected the new TB cases who were AFB negative and furthermore documented rifampicin resistance, (see Chapter 3. active case detection survey). The study showed that GeneXpert could be effectively utilized in rural hospital settings in PNG. However, the cost for installation, space, training and power requirements must be considered (2).

The TB/HIV rate remained low among study participants. Lymph node presentation was the predominate type of EPTB in Kikori, account for 57.5% of all EPTB cases. This information should be added to overall TB health education, as it is an extremely common form of TB in this area.

Nearly half of the participants reported that they sought health care due to the pressure from the family, indicating the necessity of health education to the wider community (see Chapter 4) in order to facilitate and encourage health-seeking behavior of suspected TB patients (3).

Treatment adherence is an important process of DOTS. Approximately 80% of participants achieved the satisfactory treatment outcomes (cured and treatment completed). Poor treatment outcomes were most common in patients that had <80% of supervised DOTS treatments. Similar to a study in Madang, the general health improvement, i.e., weight gain, was seen during the course of treatment. A proper understanding of side effects of TB medication is critical as it informs and reassures participants so they are more likely to complete treatment (3).

This study showed DOTS intervention in remote PNG is possible. However, DOTS needs a strategic plan using operational research assessment methods, so that over 80% satisfactorytreatment outcome can be achieved.

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CHAPTER 3. TUBERCULOSIS EPIDEMIOLOGY FROM ACTIVE CASE DETECTION SURVEY

INTRODUCTION

In PNG, only passive case finding of TB patients (i.e. only those who present to health facilities are screened and diagnosed) is adopted. Consequently, the current estimates of TB prevalence in PNG are based exclusively on notification records of TB patients that visited health facilities and received treatments. To-date active case finding surveys (i.e. actively screen and diagnose targeted populations or high risk groups) have not been executed in high potential disease burden areas where the PNG LNG Project is active, e.g., Hiri villages in the Central Province. Therefore, PNGIMR, with support from the PNG LNG Project conducted the first active case detection survey in both high impact locations, e.g., Hiri IHDSS, Kikori district and Hides Division 3 and a coastal comparison site (Karkar iHDSS) in order to determine the actual burden of TB illness in the study areas.

Hiri iHDSS

Study sites: This study was conducted in Hiri iHDSS, Central Province.

Sampling: A cross-sectional survey was carried out in Hiri iHDSS in September 2013 to February 2014. The individual is the unit of analysis as opposed to the household; therefore, the survey targeted the total population of the Hiri iHDSS. A house-to-house survey (covering all ages) was launched in order to detect individuals with cough for more than three weeks or/and who identified themselves as suffering from TB. Three weeks of persistent cough is a standard WHO criterion for possible TB. Those individuals identified as TB patients and who were undergoing TB treatment, were reviewed (utilizing their health book) for their TB treatment. IMR also crosschecked patient records in the TB registration at the local health facilities.

Two morning sputum samples were collected from prolonged cough participants on two consecutive days. The specimens were delivered to the PiHP Infectious Diseases Diagnostic POM Laboratory located at UPNG Medical School. Laboratory analysis included Acid Fast Bacilli (AFB) microscopy and reading. All slides were doubly read, the slides in which both results were not “agreed”, were sent to the PNGIMR TB lab in Madang for a third reading and confirmation of the results. All sputum samples were decontaminated according to Petroff’s method [1] and GeneXpert assays utilizing the Xpert MTB/RIF kit (Cepheid, Sunnyvale California USA) were performed. The results were recorded in the TB registration book (TB05 form) a reporting system of the National TB Control Program.

The TB register records at health facilities were reviewed to validate the survey result and in order to confirm the TB cases that had been diagnosed prior the survey in 2013.

Data analysis: All data were doubly entered in Microsoft Access database and STATA 12 (Stata Corp. College Station, TX) was used for data analysis.

RESULTS

Summary results are shown in Table 3.1 below. Data analysis also included confirmed (GeneXpert system) Hiri resident worker data obtained from the PNG LNG Project. These workers were residents of the specific villages included within the Hiri iHDSS; hence it is appropriate to utilize these data in area –wide rate calculations.

Table 3.1. Results from the tuberculosis ACD survey, Hiri iHDSS, 2013

Hiri iHDSS	Number (N=13,310)
Number of villages	4
Total population survey	13,310
Cough for more than 3 weeks	185
Sputum submitted	370
TB diagnosed from this ACD survey*	16
TB cases diagnosed by ISOS (PNG LNG workers)	18
TB rate from ACD in 2013	120/100000
TB cases from Passive case finding in 2013	34
TB rate from passive case detection in 2013	255/100000
Total new TB cases (ACD and passive detection)	61
Incidence rate of TB in 2013	458/100000
Total TB cases	68
Prevalence TB rate in 2013	510/100000
RIF + from GeneXpert	4

IMR completed the active case detection (ACD) survey in Hiri (covered 100% of 13,310 pop). The TB rate from the ACD survey is presented in Table 3.1. We detected a high rate of TB in Hiri from the ACD survey (120 or 16/13,310*100,000). Based on a review of TB records, there were 34 TB cases diagnosed from passive case detection, in addition to 18 TB cases diagnosed at the PNG LNG plant site. Therefore, there were a total of 68 TB cases in Hiri with the prevalence rate of 510/100,000 pop. The passive case detection will detect 34 cases or 255/100,000 pop or 50% of total TB cases. Without the ACD survey and the support from the PNG LNG for TB diagnosis from their local staff, the survey would not capture 34 active TB cases. IMR also detected four cases (6% or 4/68*100), which had RIF positive from GeneXpert, indicated MDR status. IMR has sent these samples for further testing at the Queensland Mycobacterium Reference laboratory in Brisbane to find out the drug resistance profile. IMR registered the three cases at the TB clinic in order to begin second line drug treatment.

A total of 82 suspected TB cases were seen at Hiri clinics in 2013, i.e., 60 were seen at Papa clinic, 13 at Porebada and 9 at Boera clinic. The total number of individuals with prolonged cough was 276 (185 from ACD survey). Eighty-two or 29% of the prolonged cough cases sought diagnosis and health care.

Of the 34 active TB cases registered in Hiri clinics, 19 were adult and 15 were pediatric cases. Of the 34 active TB cases, 29 were new and 5 cases were default/chronic cases. Of 16 cases from ACD survey, 14 cases are new and two cases are default. If all 18 TB cases from PNG LNG site were new cases, there are 61 new TB cases or an incidence of 458/100000 pop.

Treatment outcomes

PNGIMR team conducted the DOTS follow up with the TB patients recruited from the ACD survey (N=16) until December 2014. Details of TB patients diagnosed from the ACD were presented in the Table 3.2.

Table. 3.2. Details of treatment outcome of TB patients from ACD in Hiri iHDSS in 2014.

	Total number = 16
Average age	42.2 (Min =20; Max = 75)
Male vs. Female	7 vs. 9
With BCG scare	14/16
80-100% DOTS (missing medication up to 1 week, one time)	9/12*
Less than 80% (missing medication up to 2 weeks)	3/12*
BMI at enrolment	Mean 19.1 (Min=15.4; Max = 24.2)
BMI after intensive phase (N= 12 as 4 cases are MDR cases)	Mean 20.3 (Min= 16.0; Max= 24.2)
BMI after treatment completion (N=12 as 4 cases are MDR cases)	Mean 21.5 (Min= 16.4; Max= 25.7)
Treatment outcome:	
PNG LNG workers: Cured	18/18
ACD: Cured	12/12
Still on second line treatment	4

* Excluded 4 MDR/TB cases

Two of the TB patients did not have a BCG scar, both aged 69 and 75 years old. With monthly follow up from PNGIMR, 9 of 16 patients adhered well to TB treatment and only missed less than one week of treatment, while only 3 cases reported missing medication for up to 2 weeks. The means of body mass index (BMI) increased overtime during the course of treatment, i.e., the mean BMI at enrolment of 19.1 to 20.3 at 2 month-treatment and 21.5 at the end of the treatment. All TB patients who were in the ACD study, except four MDR/TB cases, had recovered within 6 month-treatment, including the 18 TB cases from the PNG LNG camp.

Kikori

Study sits: This study was a cross-sectional survey conducted into rural Kikori district in Gulf province.

Sampling: Twenty-one villages out of a total 50 villages in Kikori district were randomly selected, and included in the study. The survey was conducted in April 2013.

Survey: A house-to-house survey covering all ages was performed in order to detect individuals with cough for more than three weeks or/and who identified themselves as suffering from TB in each household. Those individuals identified as TB patients should have been undergoing TB treatment; therefore, their health books were reviewed for their TB treatment record and compliance. PNGIMR also checked the individual treatment records held in the TB registration books at the relevant health facilities.

During the survey in the Kikori villages, an IMR physician (Dr. P Harino) also examined those individuals who presented with the signs and symptoms of extra pulmonary TB. Two morning sputum samples were collected from prolonged cough participants on two consecutive days. The specimens were delivered to these IMR/TB laboratories to IMR/TB lab at Kikori hospital; and IMR/TB lab at the Medical school, UPNG, Port Moresby.

PNGIMR performed Acid Fast Bacilli (AFB) microscopy and reading. All slides were doubly read by lab-qualified staff. The slides in which both results were not agreed upon were sent to the PNGIMR TB lab in Port Moresby for a third confirmatory reading.

All sputum samples were decontaminated according to Petroff's method [4] and GeneXpert assays utilizing the Xpert MTB/RIF kit (Cepheid, Sunnyvale California USA) were performed. The results were recorded in the TB registration book (TB05 form) a reporting system of the PNG National TB control program. The TB registered records at health facilities were reviewed to validate the survey results and to confirm that TB treatment cases that had been diagnosed prior the survey in 2013 and 2014.

Data analysis

All data were doubly entered in Microsoft Access database and STATA 12 (Stata Corp. College Station, TX) was used for data analysis.

RESULTS

PNGIMR covered the Kikori active case detection (ACD) survey in 21 remote villages with total population of 9670. The TB rate from the ACD survey is presented in the Table 3.3.

Table 3.3. Summary of TB survey results in Kikori

Kikori district	**Number**
Number of villages	21
Total population survey	9670
Pulmonary TB	
Cough for more than 3 weeks during the survey	144
Number of TB suspected cases submitted sputum	109
PTB diagnosed from this ACD survey	6 (4 new cases)
PTB cases diagnosed by microscopy vs. GeneXpert	2 vs. 4
PTB rate from ACD in 2013	62/100000
PTB number from PCD in 2013	45
Prevalence of PTB in 2013	527/100000
Extra Pulmonary TB	
Extra PTB from ACD survey in 2013	16 (16 new cases)
Extra PTB from PCD in 2013	92
Prevalence of Extra PTB in 2013	1116/100000
Active case detection	
Total TB cases from Active case finding in 2013	PTB 6 + EPTB 16, Total =22
TB rate from active case detection in 2013	**227/100000**
Passive case detection	
Total TB cases from Passive case finding in 2013	PTB 45 + EPTB 92, Total =137 (104 new cases)
TB rate from passive case detection in 2013	**1417/100000**
TB Prevalence	
Total TB cases (all forms)	PTB 51+ EPTB 108=159
TB prevalence rate in 2013	1644/100000
TB newly-detected case	
Total new TB cases	Passive 104 +Active 20 =124
TB incidence rate in 2013	1290/100000
Possible MDR	
RIF + from GeneXpert	2 (died 1)
Proportion of PTB vs. EPTB (%)	32 vs. 68
Health care seeking	
Total cough more than 3 weeks	394
Cough more than 3 weeks coming to hospital	250 (63%)

PNGIMR detected 6 PTB cases from the ACD survey (62 or 9/9670*100,000) and 16 Extra PTB cases (7 lymph node, 3 abdomen, 6 with malnutrition). PNGIMR reviewed the TB records at Kikori hospital, i.e., 137 TB cases (45 PTB and 92 EPTB cases) from the study villages were diagnosed and treated. Total cases were 159 TB cases in study areas with a prevalence rate of 1644/100,000 pop. The passive case detection (PCD) had detected 137 cases: 1417/100,000 population or 86% of total TB cases. The extra PTB (EPTB) was predominant in this setting and accounted for 68% of all TB cases.

Reviews of the clinic/hospital TB registration demonstrated that there were 104 newly diagnosed TB cases in 2013. The active case detection survey detected 20 new TB cases. The total number of newly diagnosed TB in 2013 was 124. For the TB incidence rate, the denominator to calculate the

incidence rate was from the number of population at risk (total population – previous TB cases = 9640-35= 9605). The previous TB case is from the total of TB cases subtracted from the number of new TB cases (159-124=35). As shown in Table 3.2, the TB incidence rate in Kikori was much higher (1282/100,000 pop) than the incidence rate for Gulf province (785/100,000 pop) reported by NDOH in 2012 [5]. The study also detected 2 cases (1.4% or 2/146*100), which were RIF positive from GeneXpert, indicating MDR status. One case had died soon after the survey and another case was referred to POM General Hospital.

In 2013 at Kikori Hospital, a total of 248 suspected TB cases were seen at the outpatient TB clinic. The total number of prolonged cough patients was 408, of which 248 visited the TB clinic and accounted for 63% of the prolonged cough cases that sought diagnosis and health care.

Those TB patients identified by ACD were enrolled into the treatment cohort study in Kikori. The treatment outcome of these study patients was presented in the Chapter 2 in this report.

Karkar iHDSS

Study sits: This study was a cross-sectional survey conducted in Karkar iHDSS, Madang province.

Sampling: The survey at the Karkar iHDSS, covered all 21 villages in iHDSS, and was conducted in October 2013.

Survey: A house-to-house survey covering all ages was performed in order to detect individuals with cough for more than three weeks or/and who identified themselves as suffering from TB in each household. Those individuals identified as TB patients should have been undergoing TB treatment; therefore, their health books were reviewed for their TB treatment record and compliance. PNGIMR also checked the individual treatment records held in the TB registration books at the relevant health facilities.

Two morning sputum samples were collected from prolonged cough participants on two consecutive days. The specimens were delivered to the IMR/TB laboratory at Paramedical building at Divine World University (DWU) in Madang. PNGIMR performed Acid Fast Bacilli (AFB) microscopy and reading. Lab-qualified staff doubly read all slides. The slides in which both results were not agreed upon, were sent to the PNGIMR TB lab in Port Moresby for a third confirmatory reading.

All sputum samples were decontaminated according to Petroff's method [1] and GeneXpert assays utilizing the Xpert MTB/RIF kit (Cepheid, Sunnyvale California USA) were performed. The results were recorded in the TB registration book (TB05 form) a reporting system of the PNG National TB control program. The TB registered records at health facilities were reviewed to validate the survey results and to confirm that TB treatment cases that had been diagnosed prior the survey in 2013 and 2014.

Data analysis

All data were doubly entered in Microsoft Access database and STATA 12 (Stata Corp. College Station, TX) was used for data analysis.

RESULTS

Table 3.4 shows the active case detection survey covering 21 villages in the Karkar iHDSS, a total population of 18413. We detected 22 PTB cases from the ACD survey (119 or 22/18413*100,000). Of the 22 cases, 13 were new cases. This survey did not detect any MTB/RIF positive case.

Table 3.4. Summary of TB surveillance survey results in Karkar iHDSS

Karkar iHDSS	**Number**
Number of villages	21
Total population survey	18413
Pulmonary TB	
Cough for more than 3 weeks during the survey	258
Number of TB suspected cases submitted sputum	258
PTB diagnosed from this ACD survey	22 (13 new cases)
PTB cases diagnosed by microscopy vs. GeneXpert	13 vs. 9
PTB rate from ACD in 2013	119/100000
PTB number from PCD in 2013	70 (61 new cases)
Prevalence of PTB in 2013	70+22= 92 or 499/100000
Extra Pulmonary TB	
Extra PTB from ACD survey in 2013	N/A (Not conducted in this survey)
Extra PTB from PCD in 2013	44 (42 new cases)
Prevalence of Extra PTB in 2013	239/100000
Active case detection	
Total TB cases from Active case finding in 2013	PTB 22 + EPTB N/A, Total =22
TB rate from Active case detection in 2013	**119/100000**
Passive Case detection	
Total TB cases from Passive case finding in 2013	PTB 70 + EPTB 44, Total =114
TB rate from Passive case detection in 2013	**619/100000**
TB Prevalence	
Total TB cases (all forms)	Active 22+Passive 114=136
TB prevalence rate in 2013	738/100000
TB newly-detected case	
Total new TB cases (Passive) +(Active)	(PTB=61+ EPTB=42) + 13 = 116
TB incidence rate	630/100000
Possible MDR	
RIF + from GeneXpert	0
Proportion of PTB vs. EPTB (%)	67 vs. 33

Reviews of TB records held at key health facilities (Gaubin hospital and health centres) were performed. There were 114 TB cases already diagnosed and treated; therefore, there were 136 TB cases in study areas. The calculated prevalence rate was 738/100,000 pop. The passive case detection detected 619/100,000 pop or 84% of the total TB cases. In the Karkar iHDSS, PTB is the predominant form and accounted for 67% of all TB cases. The calculated TB incidence rate was 630/100,000 pop. The number of population at risk as a denominator for calculating TB incidence is (total of population – previous TB = 18413-20) 18,393.

The summary data presented in Table 3.5 (below) illustrates that the TB incidence rates across the three sites (Hiri iHDSS, Karkar iHDSS and Kikori), were significantly higher than the figures reported by the NDOH. Interestingly, the passive case detection in Kikori district and Karkar iHDSS found significantly more cases than the PCD in Hiri HDSS. The survey detected more TB with possible MDR cases (RIF+ from GeneXpert) in Hiri, than other sites.

Hides iHDSS

Study sits: This study was a cross-sectional survey conducted in Division 3, Hides iHDSS in Hela province.

Sampling: The survey, covered all villages in Division 3, Hides iHDSS, and was conducted in August 2014 and in November 2014.

Survey: A house-to-house survey covering all ages was conducted to detect individuals with cough for more than three weeks or/and who identified themselves as suffering from TB in each household. Those individuals identified as TB patients should have been undergoing TB treatment; therefore, their health books were reviewed for their TB treatment record and compliance. PNGIMR also checked the individual treatment records held in the TB registration books at the relevant health facilities.

Three morning sputum samples were collected from prolonged cough participants on three consecutive days. The specimens were delivered to these IMR/TB laboratories at PiH lab in School of Medicine, UPNG. PNGIMR performed Acid Fast Bacilli (AFB) microscopy and reading. Lab-qualified staff doubly read all slides. The slides in which both results were not agreed upon, were sent to the PNGIMR TB lab in Madang for a third confirmatory reading.

All sputum samples were decontaminated according to Petroff's method [1] and GeneXpert assays utilizing the Xpert MTB/RIF kit (Cepheid, Sunnyvale California USA) were performed. The results were recorded in the TB registration book (TB05 form) a reporting system of the PNG National TB control program. The TB registered records at health facilities were reviewed to validate the survey results and to confirm that TB treatment cases that had been diagnosed prior the survey in 2014.

Data analysis

All data were doubly entered in Microsoft Access database and STATA 12 (Stata Corp. College Station, TX) was used for data analysis.

RESULTS

Total of 112 individuals with chronic cough had submitted their sputum for the TB diagnosis tests. The demographic characteristics of the participants are presented in Table 3.5.

Table 3.5. Characteristics of participants with chronic cough in Division 3, Hides iHDSS

Characteristics	Chronic cough N = 113 (%)	TB confirmed cases N= 2
Mean age	45.9 (range: 4 to 80 years)	27.5 (25-30)
Age	1 (0.9%)	
< 5 years old	4 (3.6%)	0
5 – 15 years old	77 (68.7%)	0
16 – 59 years old	30 (26.8%)	2
≥ 60 years old		0
Sex		
Male	62 (55.4%)	2
Female	50 (44.6%)	0
Exposure to in-house smoke		
Exposed	101 (90.2%)	2
No Exposure	11 (9.8%)	0
BCG scar		
Yes	95 (84.8%)	1
No	17 (15.2%)	1
Average household member	5.3 (Min 1- Max 14)	N/A
Number of people in a household		
≤ 5		
6 – 10	36 (32.6%)	N/A
>10	22 (19.6%)	
	54 (48.2%)	
Previously sick with TB	(N=98)	
Yes	6 (6.1%)	0
No	92 (93.9 %)	2
Used to live with TB patient	(N=98)	
Yes	23 (23.5%)	1
No	75 (76.5%)	1
Chronic cough	93 (83.0%)	2
Cough up blood	3 (2.7%)	1
Weight lost	40 (35.7%)	1
Lost of appetite	15 (13.4%)	0
Night sweat	33 (29.5%)	1

The average age of the participants with chronic cough in Division 3 of Hides iHDSS was 45.9 years old. Two TB cases were diagnosed by this survey via AFB (both were 3+) and confirmed also by GeneXpert (Table 3.6). There was no other negative AFB turned to be positive with GeneXpert in this study group. The patients were new cases, aged 25 and 30 years old. Both exposed to the indoor air pollution from wood smoke inside the house and so did 90% of chronic cough participants. While chronic cough is a common symptom and prevalent, this study confirmed that the burden of TB in

this highland area was low. Historically, there is an extremely high underlying burden of respiratory pneumonia in Hides that has been documented by PNGIMR over many decades. The Hides/Tari area was the original "home location of early pneumonia vaccine trials (3). The survey on the existing TB cases in communities was conducted to determine the number via passive case detection. The survey found 7 cases, still on treatment (5 EPTB, 2 PTB); there were no "new TB cases" uncovered by PCD.

Table 3.6. Summary of TB surveillance survey results in Hides iHDSS

	Hides 4
Number of villages	4 wards
Total population survey	5596
Total chronic cough	113
TB diagnosed from Active case detection	2
% of TB detection by ACD	22%
TB rate from ACD (per 100000)	36
TB diagnosed from Passive case detection	7 (5 EPTB & 2 PTB)
% of TB detection by PCD	78%
TB rate from PCD (per 100000)	125
TB prevalence (per 100000)	160
TB incidence (per 100000)	36
TB incidence rate reported by NDOH (2012)	84
RIF+ from GeneXpert	0
Proportion of PTB vs. Extra PTB	44 vs. 56

* These percentages were calculated from the total number of TB cases (n=68; 16 from ACD + 34 from PCD + 18 from the PNGLNG plant site)
** The numerator calculated in this prevalence rate was 68; included 18 TB cases diagnosed by ISOS from the PNGLNG project.
***This rate was for the year 2012

DISCUSSION

In 2013, PNGIMR conducted the first active case detection surveys in order to investigate the burden of TB illness in rural villages in PNG: Hiri iHDSS, Central Province; Kikori district, Gulf Province; Karkar iHDSS, Madang Province and Hides iHDSS, Hela Province. The summary of findings is shown below, Table 3.7.

Table 3.7. Summary of TB surveillance survey results in 2013-2014

	Hiri	Kikori	Hides	Karkar
Number of villages	4	21	4 wards	21
Total population survey	13310	9670	5596	18413
TB diagnosed from Active case detection	16	22	2	22
% of TB detection by ACD	23%*	14%	22%	16%
TB rate from ACD (per 100000)	120	227	36	119
TB diagnosed from Passive case detection	34	137	7	114
% of TB detection by PCD	50%*	86%	78%	84%
TB rate from PCD (per 100000)	255	1417	125	619
TB prevalence (per 100000)	510**	1644	160	738
TB incidence (per 100000)	458	1290	36	630
TB incidence rate reported by NDOH (2013)	165	815	84***	276***
RIF+ from GeneXpert	4	2	0	0
Proportion of PTB vs. Extra PTB	72 vs. 28	32 vs. 68	44 vs. 56	67 vs. 33
Prolonged cough seeking health care	29%	63%	N/A	N/A

PNGIMR detected an extraordinarily high rate of TB (Incidence rate of 1290 and prevalence rate of 1684) in the Kikori study villages, while the TB rate in Hides iHDSS, Hela Province, the province adjacent to the north of Gulf Province, remained low. The current study shows that the incidence rates (per 100,000 population) estimated by the NDOH are approximately two times lower than the rates PNGIMR found in the 2013 study (Kikori 1290 vs. Gulf 815; Karkar 630 vs. Madang 276; Hiri 458 vs. Central 165) [4].

The levels of TB in Kikori are “epidemic” and require urgent intervention by the PNG National TB Control Programme. Levels in Karkar are also seriously elevated and clearly need a sustained TB control programme and intervention.

The sensitivity of AFB microscopy was 60% in this study. GeneXpert has greatly increased the sensitivity of TB diagnosis, by detecting an additional 40% of PTB, in the set of AFB “negative” microscopy results. The survey in Hiri showed higher PTB detection by GeneXpert (54%) than AFB microscopy.

TB illness patterns in PNG varied from location to location. The proportions of PTB and EPTB were different between two sites; PTB was more dominant in Karkar (67%) than in Kikori (32%). A previous survey in Hiri showed the similarly higher proportion of PTB (72%) than EPTB (28%). Four TB cases with RIF+ from GeneXpert (possible MDR TB) were found in Hiri, higher number than other

sites. This outcome warrants the further investigation, i.e., whether this is due to the high defaulted rate and/or primary drug resistance (infected with TB bacilli, already resistant to treatment).

Despite the long distance needed to travel to the Kikori hospital, 61% of prolonged cough patients sought diagnosis and care. In contrast, at the Hiri iHDSS located near Port Moresby and readily accessible by public transport, only 29% of prolonged cough cases sought health care. While the existing health system in Hiri iHDSS detected only half of all TB cases, we found that the passive case detection (PCD) in Kikori and Karkar had detected most of the TB cases (86% Kikori, 84% Karkar), which exceeded the PNG National TB Control Plan of 70% of TB case detection. These results suggested that proper diagnosis of TB at Kikori hospital and health facilities in Karkar Island is crucial and needs to be maintained.

To be able to effectively control TB in Hiri, the low utilization of health care facilities indicated the need for the active case detection to be conducted and integrated into the TB control program. Functioning DOTS programme are needed to ensure TB cases complete their treatment as well as the operational research will be especially important in designing effective health promotion interventions for promoting health seeking behavior among chronic cough group and adherence to treatment for the TB patients.

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CHAPTER 4. Tuberculosis Knowledge, Attitude and Practice

INTRODUCTION

In PNG, passive case detection is the only approach for TB case detection and relies on suspect TB cases seeking diagnosis and health care. Knowledge is one important element to facilitate this health seeking behavior. Assessment information on knowledge, local belief, attitude and practices are keys in planning the health education campaign to prevent and control TB in communities. In PNG, there are no published data regarding TB knowledge, attitude and practice studies. Therefore, given the magnitude of the TB problem in PNG, this study is critical.

MATERIALS AND METHODS

Understanding household-level health knowledge, attitudes and practices is essential for effective TB control in PNG. There is a need to (i) evaluate what level of knowledge people have regarding TB, including their belief of the causes of TB illness, (ii) understand what treatment is available, including perceptions of its "curability" and (iii) assess if the key KAP attributes will promote health seeking behaviour and compliance to treatment and care. This study aims to assess (i) the overall knowledge levels of TB among sampled community members, patients and caregivers, (ii) the perception of TB transmission, treatment and prevention among tuberculosis patients and caregivers and (iii), and the risk factors for TB infection in targeted communities.

A cross-sectional study was employed where study participants (community members, TB patients and their caregivers) aged 15 years old and over, were randomly selected from the census records of the iHDSS. Sample size calculation was performed with 95% confidence level, 5% confidence interval. The sample sizes from each iHDSS were: 369 for Asaro, 360 for Hiri and 371 for Karkar HDSSs. The study was conducted in Asaro, Hiri and Karkar iHDSS from May 2013 to December 2013. The Hides iHDSS population was not surveyed due to a combination of security, logistics and cost considerations; however, this could be performed at a later date if logistics and finding were available.

Surveys with questionnaire interviews were carried out with all the selected name lists generated by the iHDSS census records. Trained nursing officers administered the questionnaire. Questions regarding TB symptoms, causes of TB, transmission mode, how to cure TB, the prevention method from getting sick with TB and sources of TB health education were asked. The principle investigator checked all forms for their completeness and also conducted a quality checking on the initial answers by re-interviewing 25% of all questionnaires.

Data analysis

All data were doubly entered in Microsoft Access database, STATA 12 (Stata Corp. College Station, TX) was used for data analysis.

RESULTS

A total of 1034 individuals gave their consent to participate in the survey, i.e. Asaro iHDSS (359), Hiri iHDSS (295), and Karkar iHDSS (380). In the Hiri iHDSS, the participants were from Papa (41); Porebada (109); Lealea (87); and Boera (58). The demographic characteristics are shown in Table 4.1.

Knowledge and local beliefs about tuberculosis illness and treatment

Most of the participants from Hiri had higher percentages of knowledge of tuberculosis causation (bacteria-79%), transmission (airborne-84%) and risk factors (living with TB patient-85%) and how to reduce transmission (cover mount while coughing-61%) than those from Asaro and Karkar iHDSS. This level of "higher knowledge" was associated with the higher level of educational attainment observed in Hiri versus the other locations. This finding is consistent with the same observations made in Chapter 1 of this report.

Nevertheless, as shown in Table 4.2, less than half of the all participants had knowledge about risk factors for TB infection such as living in crowded house. Very few participants knew about HIV infection as an important cofactor for contracting TB. Less than 10% believed that BCG vaccination could prevent TB illness, as they observed that TB illness still occurs regardless of BCG vaccination. The majority of participants from Asaro and Karkar iHDSS indicated that they were not aware of the duration of TB medication treatment that is required, i.e., 6-8 months. The reported response for "duration of treatment" ranged from 1 week to 10 months.

Table 4.1. Socio-demographic characteristics of study population by site, iHDSS, 2013

iHDSS	Asaro		Hiri		Karkar		Total	
	N	%	N	%	N	%	N	%
Total	**359**	**34.70**	**295**	**28.50**	**380**	**36.70**	**1034**	**100**
Sex								
Male	193	53.76	120	40.68	324	85.26	637	61.61
Female	166	46.24	175	59.32	56	14.74	397	38.39
Occupation								
Subsistence farming	304	84.68	42	14.24	235	61.84	581	56.19
Student	36	10.03	15	5.08	3	0.79	54	5.22
Home duty	1	0.28	109	36.95	36	9.47	146	14.12
Private employee	6	1.67	79	26.10	67	17.63	152	14.70
Government	10	2.79	16	5.42	27	7.11	53	5.13
Others	2	0.56	11	3.73	9	2.37	22	2.13

iHDSS	Asaro		Hiri		Karkar		Total	
	N	%	N	%	N	%	N	%
Total	**359**	**34.70**	**295**	**28.50**	**380**	**36.70**	**1034**	**100**
Unemployed	0	0.00	23	7.80	3	0.79	26	2.51
Education								
None	146	40.67	5	1.69	28	7.37	179	17.31
Grade 1- 8	180	50.14	162	54.92	274	72.11	616	59.57
Grade 9 - 12	30	8.36	106	35.93	56	14.74	192	18.57
Tertiary	3	0.84	22	7.46	22	5.79	47	4.55
Marital status								
Never married	67	18.66	40	13.56	31	8.16	138	13.35
Married	258	71.87	230	77.97	291	76.58	779	75.34
Others	34	9.47	25	8.47	58	15.26	117	11.32
Smoking								
No	175	48.75	183	62.03	90	23.68	448	43.32
Yes, at the moment	29	8.08	6	2.03	10	2.63	45	4.35
Yes, sometimes	22	6.13	30	10.17	19	5.00	71	6.87
Yes, all the time	133	37.05	76	25.76	261	68.68	470	45.45
Betel nut								
No	126	35.10	24	8.14	28	7.37	178	17.21
Yes, at the moment	47	13.09	9	3.05	4	1.05	60	5.80
Yes, sometimes	44	12.26	115	38.98	20	5.26	179	17.31
Mean Age	38.7 ±14.8		39 ± 13.4		44.9 ± 13.6		41.07 ± 14.28	
House size	4.72 ± 1.66		9.64 ± 1.37		4.87 ± 2.21		6.17 ± 3.78	
Had TB illness at interview	8		14		28		50	
Have family TB history	147 (40.95%)		204 (69.15%)		273 (71.84%)		624 (60.35%)	

Table 4.2. TB knowledge among population by study sites, iHDSS, 2013

	Asaro		Hiri		Karkar		Total	
	N	%	N	%	N	%	N	%
Total number of participants	**359**	**34.70**	**295**	**28.50**	**380**	**36.70**	**1034**	**100**
TB causes by Bacteria	97	27.02	233	78.98	89	23.42	419	40.52
Airborne transmission	119	33.15	247	83.73	269	70.79	635	61.41
Risk factor-Crowded house	75	20.89	126	42.71	132	34.74	333	32.21
Risk factor-HIV infection	24	6.69	43	14.58	19	5.00	86	8.32
Risk factor-Living with TB case	249	69.36	252	85.42	232	61.05	733	70.89
Know duration of treatment	130	36.21	171	57.97	124	32.63	425	41.10
Know cost of treatment	65	18.11	133	45.08	174	45.79	372	35.98
Believe BCG can prevent TB	13	3.62	49	16.61	22	5.79	84	8.12
Cover mount while coughing	55	15.32	179	60.68	98	25.79	332	32.11

One of the common misperceptions and misunderstandings (Table 4.3) related to the causes of TB illness were attributions related to addiction to alcohol and/or smoking (29% Asaro; 5% Hiri; 24% Karkar). A common misperception was the belief that TB could be transmitted through sharing food and utensils, i.e., 55% Asaro, 11% Hiri, 31% Karkar. Skin contact with secretions from TB patients was another transmission mode belief, especially when TB patients chewed betel nut, spat saliva on the floor that in turn afforded other people an opportunity to come in contact with the saliva. Though a majority of respondents knew that living with TB patients was the most likely way to get TB infection, 38% of Hiri participants also believed that TB illness was inevitable as it passed on in the family line.

Table 4.3. Misperception and misunderstanding on the causes of TB and mode of TB transmission among study population by study site, iHDSS, 2013

	Asaro		Hiri		Karkar		Total	
	N	%	N	%	N	%	N	%
Total number	359	34.70	295	28.50	380	36.70	1034	100
Cause of TB due to								
Smoking/alcohol	104	28.97	14	4.75	91	23.95	209	20.21
Betel nut split	56	15.60	21	7.12	26	6.84	103	9.96
Sorcery and others	18	5.01	8	2.71	105	27.63	131	12.67
Do not know	84	23.40	19	6.44	69	18.16	172	16.63
TB transmission by								
Sharing food/ Lime pot	213	59.33	122	41.36	345	90.79	680	65.76
Inherit in family	23	6.41	112	37.97	32	8.42	167	16.15
Skin contact	40	11.14	52	17.63	44	11.58	136	13.15
Do not know	20	5.57	6	2.03	20	5.26	46	4.45

The perception of sorcery or witchcraft as a cause of TB was observed across all site, particularly in Karkar, i.e., 28% in Karkar, 5% in Asaro, and 3% in Hiri. In a more probing interview about sorcery, respondents felt that witchcraft can make a target person more susceptible and vulnerable to TB illness, or worsen the current TB illness, which can in turn result in death. Most TB patients believed TB treatment would cure them; however, there were reservations about the drug effectiveness, i.e., if recovery was slow, respondents believed it was due to the witchcraft or sorcery.

Severity and Susceptibility to Tuberculosis

As showed in Table 4.4, the majority of participants believed the TB was a severe illness and could kill patients and easily spread. More than half of participants in Asaro (68.25%) and Hiri (59.66%) thought that TB was a threat to their communities. Over 35% of participants indicated various forms of stigma exist among families and households of tuberculosis patients.

Table 4.4. Perception about TB illness and attitude toward TB patients by site, iHDSS, 2013

	Asaro		Hiri		Karkar		Total	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total number	**359**	**34.7**	**295**	**28.50**	**380**	**36.70**	**1034**	**100**
TB can kill	354	98.61	278	94.24	374	98.42	1006	97.29
TB being easily transmitted	318	88.58	257	87.12	350	92.11	925	89.46
TB as a threat in community	245	68.25	176	59.66	124	32.63	545	52.71
Observing TB associated stigma, discrimination	165	45.96	122	41.36	84	22.11	371	35.88

Generally, community members gave some form of support, although care was more confined within the immediate family. Assistance was given not from within close contacts of TB patients, as there was fear of catching the disease. It was common that upon hearing of TB within a family member many respondents expressed both sympathy and fear. In many homes of TB patients, the family members separated eating utensils and food.

Sources of TB health education

Around one third of participants had learned about tuberculosis from health workers. The second most common source of information was through family members and friends. School curriculum is also another main source of TB health education. Only a small number of respondents mentioned TB awareness via NGO groups, radio and IEC materials.

Table 4.5. Sources of TB information, education and communication by site

	Asaro		**Hiri**		**Karkar**		**Total**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total	**359**	**34.70**	**295**	**28.50**	**380**	**36.70**	**1034**	**100.0**
Health centres	139	38.72	94	31.86	107	28.16	340	32.88
Posters/ pamphlets	49	13.65	31	10.51	41	10.79	121	11.70
School curriculum	35	9.75	93	31.53	38	10.00	166	16.05
TB awareness activities	6	1.67	22	7.46	85	22.37	113	10.93
TV/Radio broadcast	3	0.84	10	3.39	3	0.79	16	1.55
Friends / families	102	28.41	42	14.24	84	22.11	228	22.05
Do not know	25	6.96	3	1.02	22	5.79	50	4.84

DISCUSSION

Most of respondents from Asaro and Karkar iHDSS had limited knowledge of the causes of TB and significant misunderstandings about the mode of TB transmission. Similar to a study in Central Tanzania, knowledge and perception of TB illness among communities varied greatly and incorrect views such as TB transmission via sharing domestic utensils were frequent [1]. Such perceptions can be re-enforced by misguided health messages by health providers such as in the Philippines where nurses advised TB patients to use separate eating utensils. While aiming to achieve maximum prevention, such advice resulted in stigmatization of TB patients [2]. Numerous studies pointed out that insufficient understanding of the causes of TB and protection against the disease trigger fear of infection and this fear in-turn influences the attitudes and behaviours of the community when interacting with TB patients by "judging and shaming TB patients" [3,4,5]. The fear of stigmatization and discrimination from their families was a common reason for participants not seeking diagnosis [10].

In order for TB control to be effective and achievable, TB cases need to be detected earlier and cured with DOTS as an effective treatment approach [6]. In line with a study in Vietnam, a better understanding of TB from biomedical knowledge is associated with high levels of education but not with their health seeking action [7]. Interventions to promote health seeking behaviour among groups/individual with chronic cough are urgently needed.

Existing health education had raised some level of awareness of TB in PNG. However, more specific TB control promotion is needed to link the awareness raised from health education and to better health seeking action. Closer distance from home to health centre, which allows for easier access to healthcare services, is the main factor for patients visiting health centres [8]. A study in China showed that women and elder were less likely to seek health care and/or they sought health with lesser qualified health care providers due to the financial burden [9]. TB treatment and diagnosis in PNG are free of charge and available only at the public health services; however, other costs from seeking health care such travel and lost wages/labour were pointed out by respondents and the their importance as an impediment to seeking care needs to be explored in the PNG context in order to improve the logistics of DOTS delivery.

In particular among PNG males, the delay in seeking health care was due to the perception of cough as a minor condition [10]. The first goal for TB health promotion needs to be to get people to recognize that prolonged cough is a serious condition that requires urgent diagnosis and treatment. Once the patients received TB diagnosis and treatment, proper adherence to the treatment is equally important. Future health education messages should therefore aim to improve knowledge, encourage the appropriate health seeking and treatment adherence of TB patients and reduce stigmatization of TB patients in the community. As this study showed that the majority of respondents did not know the duration of treatment. A TB study in Madang found that when TB patients started feeling better, they would discontinue the treatment. Furthermore, movements of TB patients whilst on treatment, without a proper transfer and follow-up system greatly affected TB treatment adherence and compliance [10].

Comprehensive health education will target and steer family members and community members to be involved in TB awareness. TB awareness should be integrated into the health care system [3, 4, 5]. The existing channel such as health officers and peer groups or school students in community can be mobilized and developed to be part of TB health care partnership.

Nonetheless, health education alone will not be effective for TB prevention and control as long as the PNG rural health system continues to decline. Across rural PNG, significant numbers of health care centers and aid posts have closed and/or are non-functional. Without adequate health care delivery infrastructure TB cannot be adequately managed and the burden of disease will simply increase. Since 2007, the National Department of Health of PNG has received significant funding from the Global Fund to implement DOTS. The dissemination of this funding to local rural levels is problematic and largely consistent with the general decline in rural health care services across PNG. The PNGIMR study can provide guidance in order to improve the DOTS infrastructure and service delivery in rural areas. However, both as indicated by all the PNGIMR TB studies, both passive and active case detection are needed and must be integrated into an overall control programme, particularly for rural settings. Without a robust and integrated TB control programme, the burden of TB in PNG will inevitably increase with severe public health and economic consequences.

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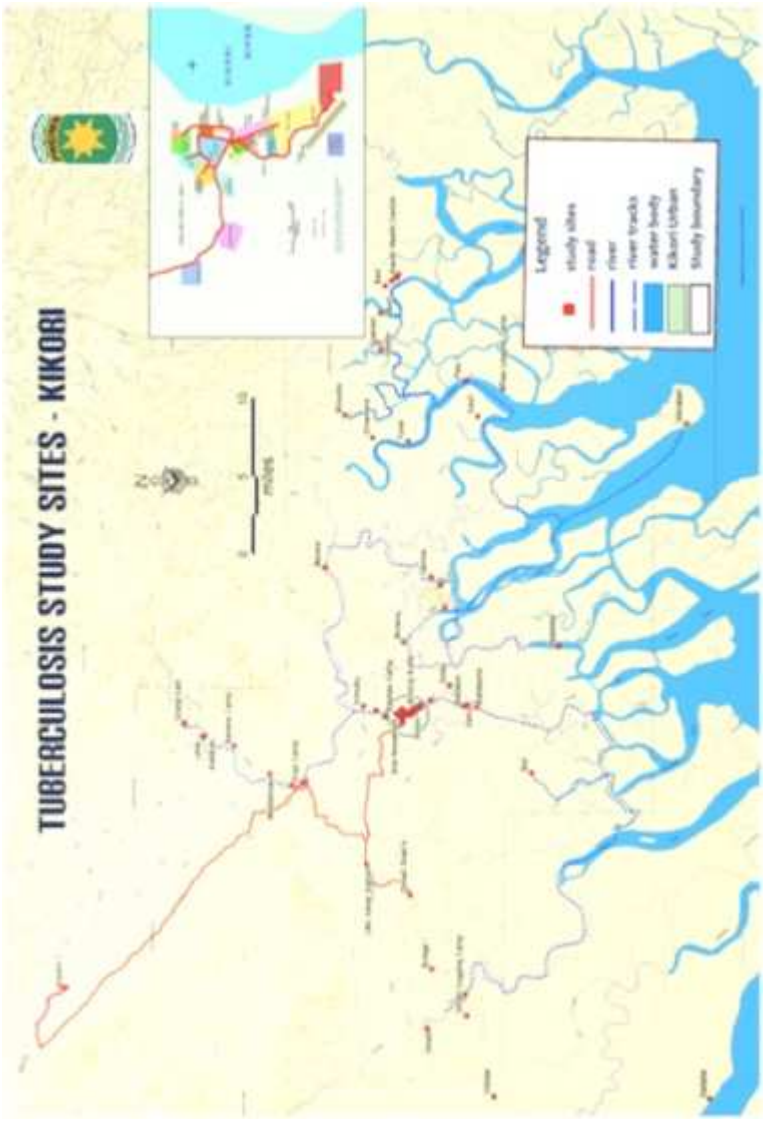
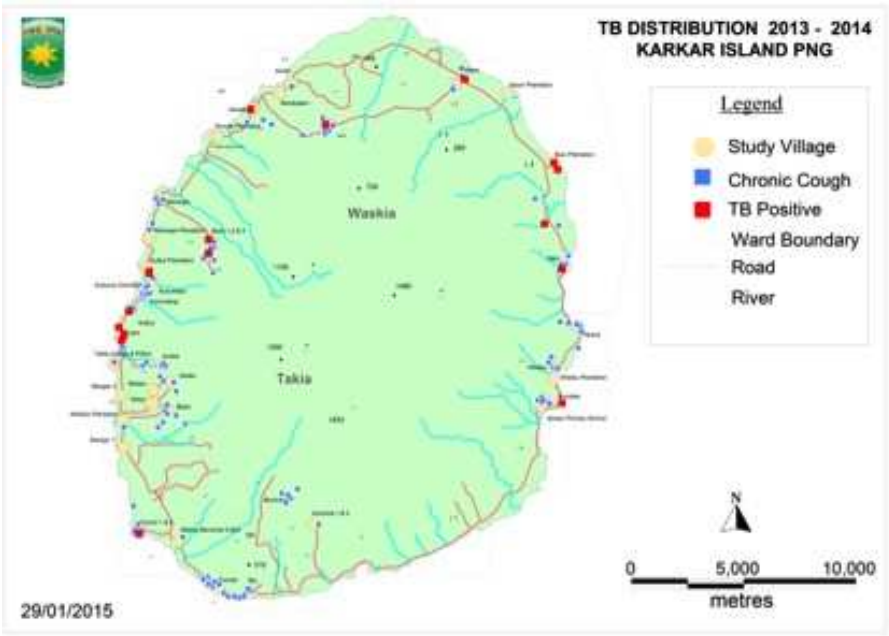
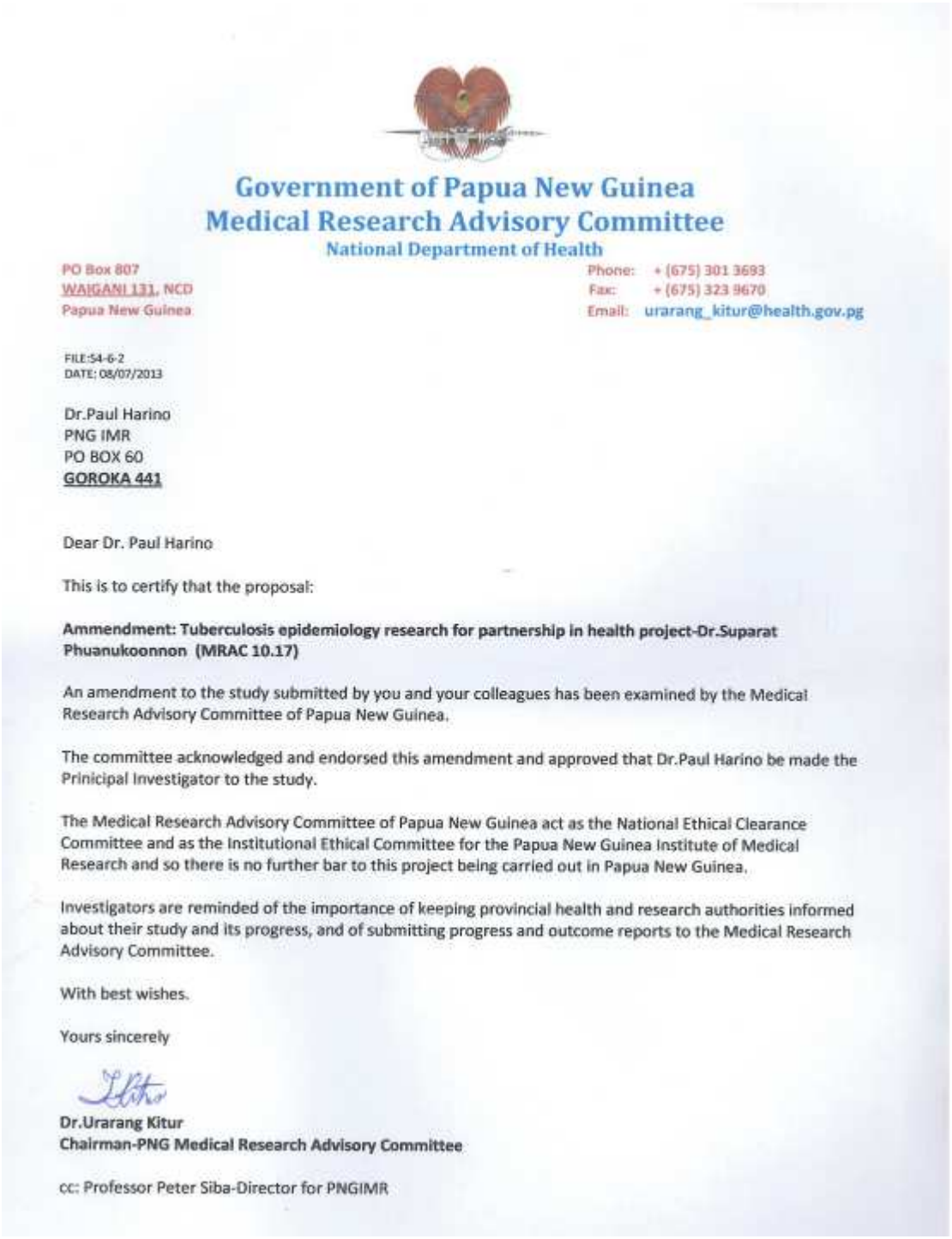
APPENDIX 1. TB DISTRIBUTION IN KIKORI 2012-2013



APPENDIX 2. TB DISTRIBUTION FROM ACD SURVEY 2013, KARKAR iHDSS



APPENDIX 3. THE MRAC APPROVAL LETTER



Government of Papua New Guinea
Medical Research Advisory Committee
National Department of Health

PO Box 807
WAIGANI 131, NCD
Papua New Guinea

Phone: + (675) 301 3693
Fax: + (675) 323 9670
Email: urarang_kitur@health.gov.pg

FILE:54-6-2
DATE: 08/07/2013

Dr.Paul Harino
PNG IMR
PO BOX 60
GOROKA 441

Dear Dr. Paul Harino

This is to certify that the proposal:

Ammendment: Tuberculosis epidemiology research for partnership in health project-Dr.Suparat Phuanukoonnon (MRAC 10.17)

An amendment to the study submitted by you and your colleagues has been examined by the Medical Research Advisory Committee of Papua New Guinea.

The committee acknowledged and endorsed this amendment and approved that Dr.Paul Harino be made the Prinicipal Investigator to the study.

The Medical Research Advisory Committee of Papua New Guinea act as the National Ethical Clearance Committee and as the Institutional Ethical Committee for the Papua New Guinea Institute of Medical Research and so there is no further bar to this project being carried out in Papua New Guinea.

Investigators are reminded of the importance of keeping provincial health and research authorities informed about their study and its progress, and of submitting progress and outcome reports to the Medical Research Advisory Committee.

With best wishes.

Yours sincerely

Dr.Urarang Kitur
Chairman-PNG Medical Research Advisory Committee

cc: Professor Peter Siba-Director for PNGIMR