

Birth defects in a rural province in Papua New Guinea

Anna Toti,¹ Beryl Vetuna,² Veronica Kalit,² Trevor Duke ^{3,4}

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¹Port Moresby General Hospital, Port Moresby, National Capital District, Papua New Guinea

²Paediatrics, Rabaul Provincial Hospital, Rabaul, East New Britain, Papua New Guinea

³Child Health, University of Papua New Guinea, Waigani, Papua New Guinea

⁴Department of Paediatrics, University of Melbourne, Melbourne, Victoria, Australia

Correspondence to

Prof Trevor Duke;
trevor.duke@rch.org.au

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ABSTRACT

Background Globally, birth defects are the fourth most common cause of neonatal mortality. They cause substantial morbidity, and often long-term disability. Despite this, the impact of birth defects on public health has received little attention in low- and middle-income countries.

Aims To report the types, incidence and geographic distribution of birth defects in the East New Britain Province of Papua New Guinea.

Methods Data were collected over 3 years on newborns with birth defects seen at Rabaul Hospital, born anywhere in the province. Each affected newborn was examined, the anomaly diagnosed and classified. The exact home location was recorded to understand geospatial distribution. To calculate incidence, data were collected on all newborns with a congenital anomaly in a cohort of 2000 consecutive live births at Rabaul Hospital in 2019.

Results Over 3 years, 2018–2020, 137 newborns with birth defects were identified, born in any part of the province. Congenital heart defects, hydrocephalus, microcephaly, craniofacial anomalies, imperforate anus, trachea-oesophageal fistula and diaphragmatic hernia were the most common anomalies. Eight cases of Down syndrome and other chromosomal anomalies were identified. The incidence in 2019 was 14 per 1000 live births. Geographic mapping showed the highest number of cases in the region on the Gazelle Peninsula, the area around the active volcanos.

Conclusions This study provides insights into the incidence and types of birth defects in a rural island province and showed it was possible to map geospatial distribution to further explore epidemiology.

INTRODUCTION

Birth defects, structural and functional physical changes that are present at birth, are the fourth most common cause of neonatal mortality in low and middle-income countries (LMIC), after prematurity and low birth weight, perinatal asphyxia and infections.¹ Papua New Guinea (PNG) like most LMIC lacks adequate data regarding birth defects. Birth defects have received little attention despite their impact on the health and development of children worldwide. Most LMIC lack registries and data regarding types and prevalence of birth defects, which could prove useful for raising awareness and guiding policies for national birth defects programmes. Far from being conditions for which nothing can be done, a significant proportion of birth defects can be prevented and treated, and consequent disability reduced. For these reasons, we sought to understand the epidemiology of birth defects in PNG.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Epidemiology of birth defects is not well described in low and middle-income (LMIC) countries.

WHAT THIS STUDY ADDS

⇒ The common types of birth defects and their incidence in a rural province.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The importance of birth defects in neonatal morbidity in LMIC, the need for programs to address preventable and correctable lesions, and to support children with chronic illness and disability.

⇒ Geospatial mapping can help understand disease distribution.

Since 2010, in PNG, numbers of selected birth defects are recorded in the Paediatric Hospital Reporting programme and reported in the Annual Morbidity and Mortality Reports produced by the Paediatric Society of PNG.² For example, in 2019, 275 newborns were reported with congenital malformations, of which 89 had multiple defects with an overall case fatality rate of 29.5%. However, these are a minority of all birth defects that occur in PNG, and these data do not enable an understanding of incidence or other epidemiological aspects.

One published hospital-based study³ and two unpublished studies^{4 5} have reported birth defects in PNG. The incidences reported (per 1000 live births) were 12 in 1985,³ 8 in 1987–1996⁵ and 28 in 2018.⁴ There have been no studies looking at population-based data or geographical distribution of birth defects in PNG.

METHODS

We conducted a 3-year study of newborns delivered at, referred to, or brought by parents or caregivers to Rabaul Hospital between 1 January 2018 and 31 December 2020, to describe and classify the types of birth defects and to map the geospatial distribution of birth defects in the province. Because the population-numerator is uncertain (ie, many births occur in villages and are unrecorded), in a consecutive cohort of the first 2000 live births at Rabaul Hospital in 2019, we calculated the incidence of birth defects.

Included in this study were all newborns with a birth defect with gestational age of 28 weeks or more, and weight of 1000 g or more.



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Three following data collection and case ascertainment tools were used to diagnose and classify birth defects:

1. WHO Birth Defects Surveillance: quick reference handbook of selected birth defects and infections.⁶
2. ICD-10 code Q80-89 classification of congenital malformation syndromes with anomalies occurring in multiple systems.⁷
3. Comprehensive New Born Screening: handbook for screening visible birth defects at all delivery points.⁸
4. Birth Defects Surveillance: a manual for programme managers second edition.¹

We designed forms that were completed as cases were identified and we gathered data from the special care nursery admission register, and the labour ward birth register. An electronic version of a proforma was designed using Adobe LiveCycle Designer ES V.8.2 to record patient information.

We describe the types and geographic distribution of cases of birth defects in East New Britain Province. The cases were mapped using the following steps. The primary place of residence of the mothers during their pregnancy was determined and classified according to the census division of wards. Coordinates of wards (local level government) were determined using geodata reference tables for East New Britain Province. An Excel spreadsheet of the co-ordinates was created and exported to Quantum Geographic Information System (QGIS, <https://qgis.org/en/site/>), which is publicly accessible downloadable software. The QGIS software was used to plot all cases on a map of East New Britain. Data on the distribution of volcanic activity were gathered from the Global Vulcanism Project at the Smithsonian Institute.⁹

To explore apparent geospatial patterns, we used the number of birth defects identified from each district, in relation to the estimated district populations from most recent PNG census. These 2011 census estimates had been extrapolated to estimates of expected population in 2019 by the PNG National Health Statistics Office, as there were no more recent other population data.¹⁰

The study was approved by the Rabaul Provincial Hospital Administration and Clinical Governance Committee.

RESULTS

In the 3 years, 2018 to 2020, 137 newborns with birth defects were seen at Rabaul Hospital, all born in East New Britain Province (table 1, and online supplemental file). Congenital heart defects, hydrocephalus, microcephaly, craniofacial anomalies including cleft lip and palate, imperforate anus and other obstructive lesions of the gastrointestinal tract, trachea-oesophageal fistula and diaphragmatic hernia were the most common anomalies. Eight cases of Down syndrome, plus other chromosomal anomalies, were identified.

Among 2000 consecutive live births at Rabaul Hospital in 2019, 28 infants had birth defects, giving an incidence of 14 per 1000 live births.

The home location of each of the 137 affected newborns is mapped in figure 1. Cases appeared to be more concentrated near interdistrict borders and mountain ranges along the Gazelle Peninsula (figure 2), where the Rabaul volcanos are active. The distribution of volcanic activity in the Gazelle Peninsula is included in figure 2.⁹

Table 2 explores the incidence per estimated district population. Based on these data, there was no evidence of disproportionate incidence of cases of birth defects relative to district population estimates.

Table 1 Birth defects seen at Rabaul Hospital 2018–2020 born at any health facility or born in villages in East New Britain Province

Type of birth defect	Number (%)
Congenital heart disease	37 (27.0)
Central nervous system anomalies	19 (13.9)
Hydrocephalus	5
Microcephaly	5
Anencephaly	3
Cervical meningocele	2
Craniofacial anomalies	19 (13.9)
Cleft lip and palate	8
Isolated cleft soft palate	2
Isolated cleft palate	1
Craniofacial anomalies—cleft palate, microtia, facial hypoplasia	1
Choanal atresia	1
Laryngomalacia	3
Microphthalmia	1
Pierre Robin sequence	2
Chromosomal and identifiable genetic syndromes	26 (19.0)
Down syndrome	8
Patau syndrome	4
Treacher-Collins syndrome	1
Undiagnosed chromosomal syndrome	13
Gastrointestinal system and abdominal anomalies	14 (10.2)
Imperforate anus	8
Duodenal atresia	1
Caecal stenosis	1
Gastroschisis	1
Omphalocele	1
Umbilical hernia	2
Respiratory and thoracic anomalies	12 (8.7)
Tracheo-oesophageal fistula	5
Diaphragmatic hernia	4
Laryngomalacia	3
Musculoskeletal and limb anomalies	6 (4.4)
Skeletal dysplasia	1
Syndactyly	1
Talipes	3
Renal and genitourinary anomalies	4 (2.9)
Hydrocoele/hypospadias/micropenis/phimosis	4
Congenital malformation syndromes affecting multiple systems	7 (5.1) *
Total	137

*Based on ICD-10 code Q80-89 classification of congenital malformation syndromes with anomalies occurring in multiple systems.⁷ These seven cases are also listed according to individual systems affected. Includes one case of congenital rubella syndrome.

DISCUSSION

This study provides insights into birth defects in the East New Britain Province of PNG. The incidence was 14 per 1000 live births. The most common types of birth defect identified were congenital heart defects, hydrocephalus and microcephaly, craniofacial anomalies and obstructive lesions of the gastrointestinal tract. This incidence is similar to that reported in other studies in PNG in the last 30 years.^{3–5} Although in high-income countries hospital-based data overestimates the incidence of congenital anomalies at a population level, in rural PNG, as in many low-income settings, there is no antenatal diagnosis of birth defects, therefore referral bias is absent. There may be a

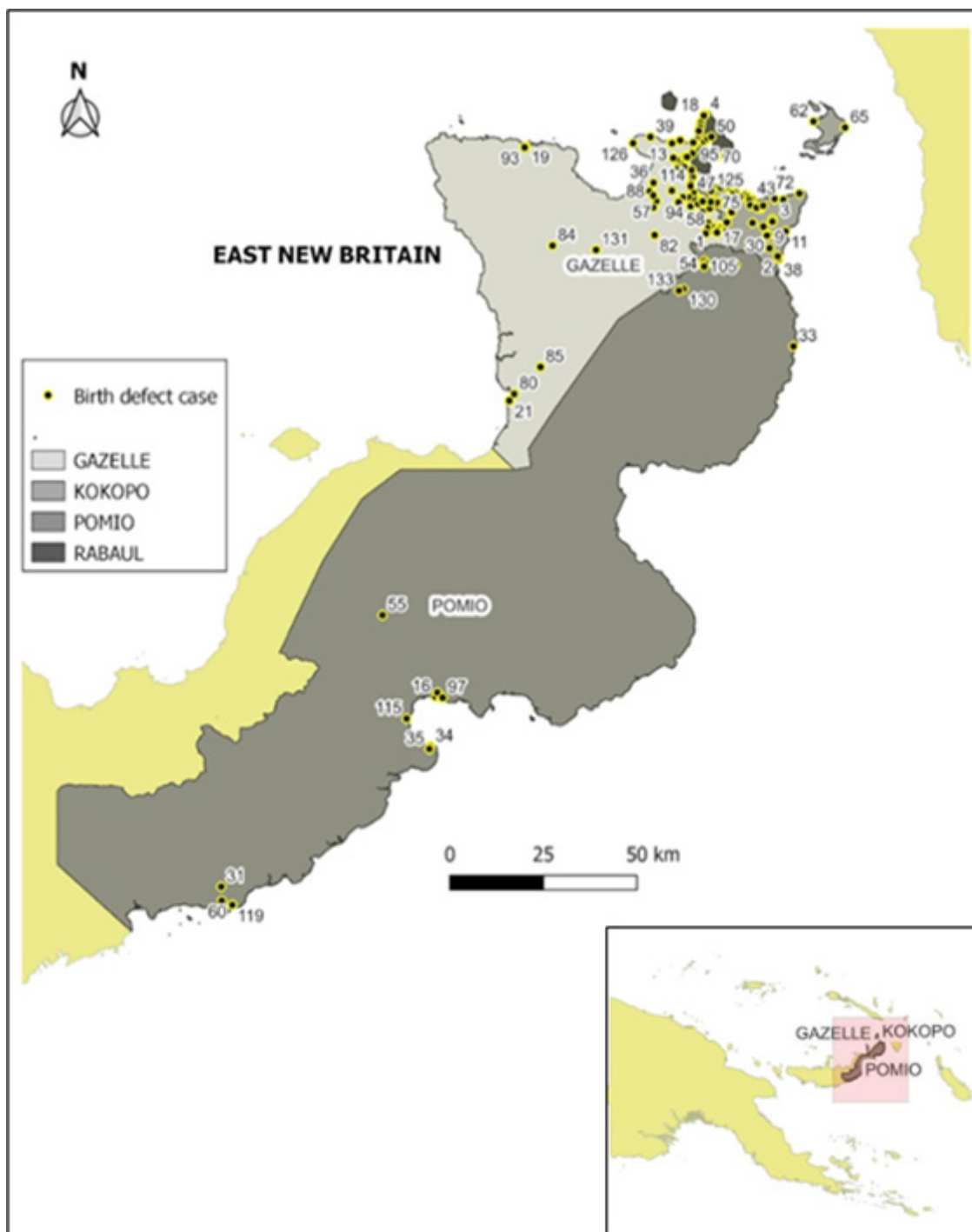


Figure 1 Geospatial mapping of birth defects identified over a 3-year period in the four districts of East New Britain Province. Numbers are birth defect case numbers.

small bias from antenatal referral of mothers for maternal high risk, which may in turn be associated with a higher risk of birth defect in a newborn, but this effect is very small in such settings. The hospital acts as a community hospital, so the 2000 consecutive births at the hospital reflect similar births in the catchment community.

It is more likely that we *underestimated* the *number* of birth defects throughout the province in the 3-year period we evaluated. In East New Britain, 40% of mothers deliver outside the main health facilities in the province, which is why we could not calculate an incidence for the entire 3-year cohort.¹¹ We almost

certainly underestimated infants born with birth defects in more remote parts of the province, as some affected newborns will not be brought to hospital or may die before they can be brought to hospital.

Finding of cases apparently concentrated along the Gazelle Peninsula was not expected. This may reflect access bias, that is the population of mothers bringing their newborns to Rabaul Hospital will be influenced by geographical access, as is referral of newborns recognised as having birth defects in remote health facilities. It was difficult to investigate this apparent clustering based on incidence per district population, as the Gazelle

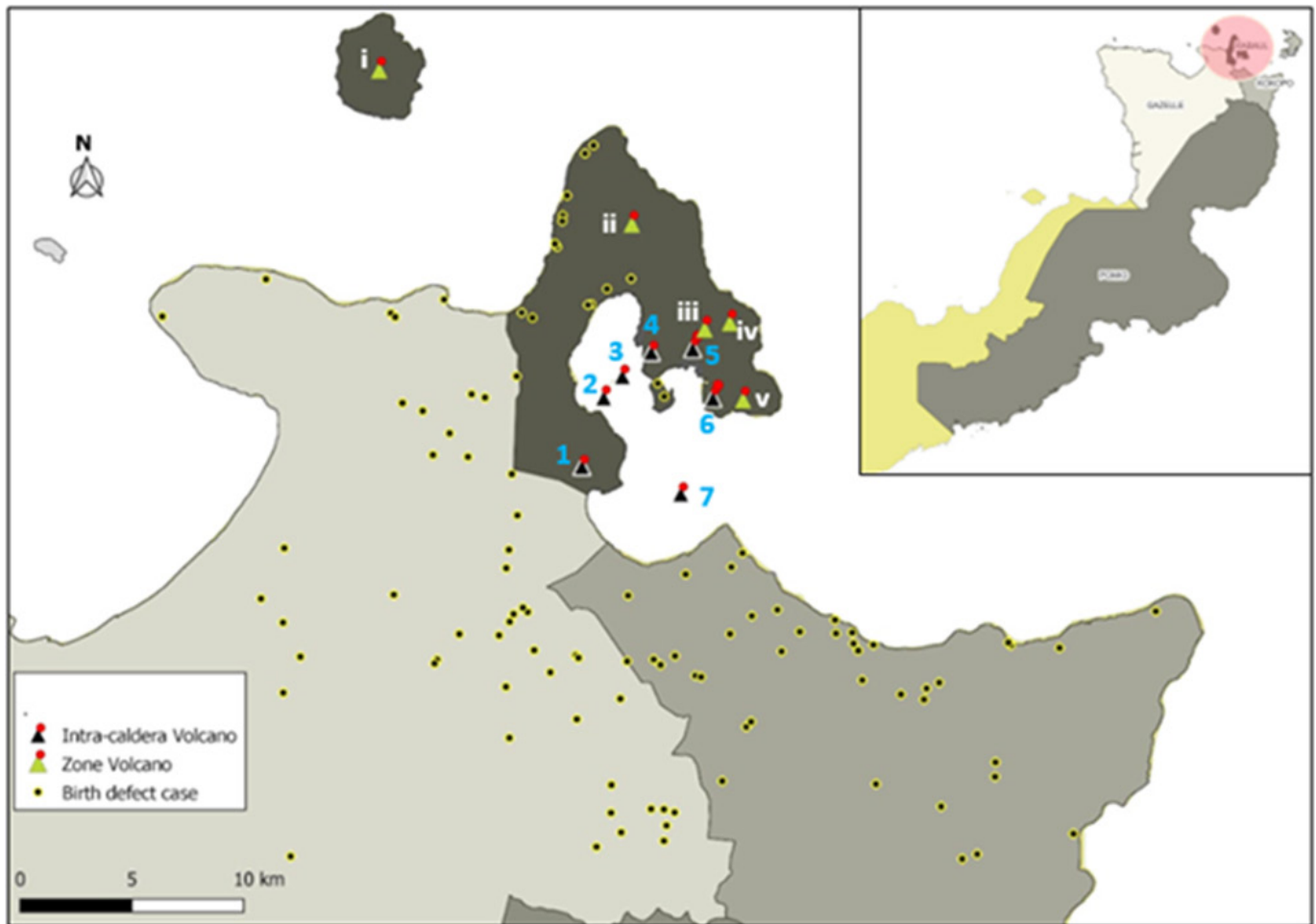


Figure 2 Geospatial mapping of birth defects identified over a 3-year period with focus on the region of the Gazelle Peninsula. Numbers are birth defect case numbers. The volcanic regions of the northern part of the Gazelle Peninsula lie within the Pacific Ring of Fire.⁹ These include the Rabaul Caldera and the Watom-to-Turagunan Zone with either landform or submarine volcanoes that are active, dormant or extinct after previous activity. The Rabaul Caldera has seven intra-caldera volcanoes—1. Vulcan, 2. Un-named, 3. Dawapia Rocks, 4. Sulphur Creek, 5. Rabalanakaia, 6. Taurvurur and 7. Karavia Bay caldera. The Watom-to-Turagunan Zone has five zone volcanoes—i. Watom, ii. Tovanumbatir, iii. Palangianga, iv. Kabiou and v. Turagunan.

Peninsula overlaps more than one district (the north-eastern tip of Gazelle district and all of Kokopo and Rabaul districts), and population estimates of the Gazelle Peninsula per se do not exist. The only data we had on population, represented in table 2, did not support a clustering.

Table 2 Distribution of birth defects by district over 3 years (2018–2020)

Districts	Number of cases observed (% of all cases)	District population (% of district population in the province) in 2019 *	Population density (population per km ² ¹⁰)	Estimated incidence of birth defects per 1000 population
Gazelle	58 (42)	149538 (41)	35	0.39
Kokopo	44 (32)	97184 (27)	220	0.45
Pomio	19 (14)	74896 (20)	6.5	0.25
Rabaul	16 (12)	45005 (12)	410	0.36
Total	137 (100)	366623 (100)		0.37

*Population estimates for 2019 extrapolated by the National Statistics Office from 2011 census data.

However, causes of potential clustering in this region, particularly environmental factors, warrant consideration. The Gazelle peninsula surrounds the active Rabaul volcanoes, and cadmium is a heavy metal that is found in high concentrations in volcanic ash emissions. On the Gazelle Peninsula, significant levels of cadmium have been detected in the local food chain.¹² As an environmental toxin cadmium accumulates in marine ecosystems,¹³ food chains and within living organisms. Cadmium exposure in humans has been linked to a higher risk of preterm delivery,¹⁴ congenital heart disease,¹⁵ cleft palate and other teratogenic effects as well as chronic adult diseases.¹⁶ In 2013, an agricultural study in the East New Britain Province identified high levels of cadmium in vegetables, nuts, marine organisms and tobacco. There was evidence of significant levels of cadmium in the food chain around the volcano, and that study proposed it may be associated with adult diabetes and hypertension seen in East New Britain.¹²

Our study cannot shed more light on whether the apparent distribution of birth defects resulted from differences in population density, access to the provincial hospital, referral bias, environmental exposure related to the volcano or other unknown factors. However, there is a need for further intersector research

into cadmium and other volcanic toxins to inform public health policies.

In PNG and other LMIC, tools and guidance are needed for identification of birth defects to aid diagnosis by primary healthcare workers, reporting and research. Healthcare workers need referral guidelines for birth defects, as many are treatable, or managed in a way that reduces disability. While national population-based surveillance may not be feasible at this time, sentinel hospital-based surveillance via the Paediatric Hospital Reporting system is possible and increased awareness and reporting of birth defects through this programme is needed.²

Although we cannot quantify this from our data, some birth defects are preventable, and there is a need for feasible approaches in low resource settings: prevention of sexually transmitted diseases, vaccination against rubella and fortification of staple foods with folic acid, iodine and other micronutrients as well as investigation and legislation controlling management of toxic chemicals. These approaches should be coupled with strengthened prenatal and perinatal services, including promotion of family planning, expanding rubella immunisation before pregnancy and implementing folic acid fortification of commonly consumed foods. We could not test for rubella, zika virus or other congenital infections, but note there were five cases of microcephaly, and one case that fulfilled clinical criteria for congenital rubella syndrome.

There should be training of healthcare professionals in best practices in the care and prevention of birth defects and in the practical application of medical genetics, at both the undergraduate and postgraduate levels. Principles of genetic counselling can also be taught to nurses and doctors in training.

Education of the community is also needed on the steps that can be taken to promote healthy outcomes of pregnancy, including the avoidance of potential teratogens during gestation, particularly alcohol, and on the importance of knowing how and when to access prenatal care.

The encouragement of parent and patient organisations to help each other and advocate for better services for children with birth defects is important. Parent groups can draw attention to the need for improved clinical, educational and social services for children with congenital and acquired disability to assert their right to be treated with dignity and without discrimination.

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Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval This study involved human participants and was approved by Rabaul Provincial Hospital Administration and Clinical Governance Committee. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer-reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information.

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ORCID iD

Trevor Duke <http://orcid.org/0000-0003-4637-1416>

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Rabaul Hospital Based Birth Defects Study

- 137 cases recorded over a 3-year period 2018 – 2020
- Includes 28 cases of the live birth series of 2019
- Also included, geospatial co-ordinates of the mother's primary residence i.e census unit (CU)
- Geographic Information System software QGIS v2.8.1 and v 3.22.9
Co-ordinate Reference System WGS 84 Authority ID EPSG:4326 (OTF)

Unique Study Identifier	Live Birth Series No.	Date of Recruitment	Facility of Birth or Referral	Facility Type	Sex	Birth Defect	Classification of Birth Defect	Ward	Local Level Government	District	CU_Longitude	CU_Latitude
1	-	07-Jan-18	St Mary's Hospital Vunapope	Hospital	Male	Micropenis	Renal and genitourinary anomalies	Viviran 1	Toma-Vunadidir	Gazelle	16939466.24	-492252.3406
2	-	26-Jan-18	St Mary's Hospital Vunapope	Hospital	Male	Unilateral cleft lip/palate, Congenital heart disease	Other congenital malformation syndromes affecting multiple systems	Mope	Bitapaka Rural	Kokopo	16957605.56	-498953.5007
3	-	01-Feb-18	St Mary's Hospital Vunapope	Hospital	Female	Tracheo-oesophageal fistula	Cardiothoracic anomalies	Kabakaul	Kokopo-Vunamami	Kokopo	16956906.82	-483852.3047
4	-	02-Feb-18	Rabaul Provincial Hospital	Hospital	Male	Choanal atresia	Central nervous system, head, and neck anomalies	Tavui 1	Balanataman	Rabaul	16938228.88	-461413.6003
5	-	21-Mar-18	St Mary's Hospital Vunapope	Hospital	Female	Congenital heart disease	Cardiothoracic anomalies	Ulaulatava	Kokopo-Vunamami	Kokopo	16945061.69	-487514.3198
6	-	25-Mar-18	St Mary's Hospital Vunapope	Hospital	Female	Congenital heart disease	Cardiothoracic anomalies	Kokopo	Kokopo-Vunamami	Kokopo	16949082.11	-483318.9616
7	-	21-Mar-18	Rabaul Provincial Hospital	Hospital	Female	Undiagnosed syndrome	Chromosomal or identifiable genetic syndromes	Navunaram	Central Gazelle	Gazelle	16934819.16	-478017.1667
8	-	25-Mar-18	Rabaul Provincial Hospital	Hospital	Female	Congenital heart disease	Cardiothoracic anomalies	Nabata	Livuan-Reimber	Gazelle	16929157.3	-468946.0278
9	-	02-Apr-18	Rabaul Provincial Hospital	Hospital	Male	Cervical meningocele	Central nervous system, head, and neck anomalies	Vunabaur	Bitapaka Rural	Kokopo	16955416.67	-496766.8367
10	-	18-May-18	St Mary's Hospital Vunapope	Hospital	Male	Umbilical hernia	Gastrointestinal system, abdominal anomalies	Bitapabeke	Kokopo-Vunamami	Kokopo	16946643.61	-484127.9336

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11	-	26-May-18	St Mary's Hospital Vunapope	Hospital	Male	Talipes	Musculoskeletal, limb anomalies	Bilur	Bitapaka Rural	Kokopo	16959707.54	-492313.1226
12	-	24-May-18	Rabaul Provincial Hospital	Hospital	Male	Down Syndrome	Chromosomal or identifiable genetic syndromes	Tinganagalip	Central Gazelle	Gazelle	16934436.98	-479564.9958
13	-	25-Jun-18	Rabaul Provincial Hospital	Hospital	Female	Cleft lip and palate	Central nervous system, head, and neck anomalies	Nabata	Livuan-Reimber	Gazelle	16929348.39	-469118.0065
14	-	26-Jun-18	St Mary's Hospital Vunapope	Hospital	Male	Talipes	Musculoskeletal, limb anomalies	Ulaveo	Bitapaka Rural	Kokopo	16959085.53	-483968.6587
15	-	09-Jun-18	St Mary's Hospital Vunapope	Hospital	Female	Congenital heart disease	Cardiothoracic anomalies	Kokopo Town	Kokopo-Vunamami	Kokopo	16949865.57	-483777.5713
16	-	05-Jul-18	Rabaul Provincial Hospital	Hospital	Female	Hydrocephalus	Central nervous system, head, and neck anomalies	Pomio	Central-Inland Pomio	Pomio	16866094.85	-615334.4945
17	-	26-Jul-18	Warangoi Rural Hospital	Hospital	Male	Imperforate anus, dextrocardia, talipes	Other congenital malformation syndromes affecting multiple systems	Wairiki 1	Toma-Vunadidir	Gazelle	16941377.15	-491220.4473
18	-	24-Aug-18	Rabaul Provincial Hospital	Hospital	Male	Diaphragmatic hernia	Gastrointestinal system, abdominal anomalies	Tavui 1	Balanataman	Rabaul	16937846.72	-461776.6713
19	-	25-Aug-18	Rabaul Provincial Hospital	Hospital	Male	Cleft lip and palate	Central nervous system, head, and neck anomalies	Lassul	Lassul-Baining	Gazelle	16890222.29	-469906.383
20	-	17-Sep-18	Paparatava Health Centre	Health Centre	Male	Undiagnosed syndrome	Chromosomal or identifiable genetic syndromes	Bitakapuk 3	Toma-Vunadidir	Gazelle	16939026.72	-490121.6778
21	-	20-Sep-18	Rabaul Provincial Hospital	Hospital	Male	Micropenis, anophthalmia, Congenital heart disease	Other congenital malformation syndromes	Open Bay	Lassul-Baining	Gazelle	16885807.99	-537046.5415

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							affecting multiple systems					
22	-	05-Sep-18	St Mary's Hospital Vunapope	Hospital	Female	Pierre Robin sequence	Central nervous system, head, and neck anomalies	Kokopo Town	Kokopo-Vunamami	Kokopo	16949808.24	-483280.7441
23	-	20-Oct-18	Rabaul Provincial Hospital	Hospital	Female	Congenital heart disease	Cardiothoracic anomalies	Matupit	Kombiu Rural	Rabaul	16941106.02	-472095.0505
24	-	19-Nov-18	St Mary's Hospital Vunapope	Hospital	Female	Congenital heart disease	Cardiothoracic anomalies	Nanuk	Raluana	Kokopo	16944339.57	-483340.0025
25	-	12-Nov-18	St Mary's Hospital Vunapope	Hospital	Male	Patau syndrome	Chromosomal or identifiable genetic syndromes	Kabagap - Ravat	Raluana	Kokopo	16940919.05	-484486.5426
26	-	19-Nov-18	Napapar Health Subcentre	Health Subcentre	Female	Talipes	Musculoskeletal, limb anomalies	Ululatava	Kokopo-Vunamami	Kokopo	16945281.44	-487285.015
27	-	19-Nov-18	Keravat Rural Hospital	Hospital	Male	Imperforate anus	Gastrointestinal system, abdominal anomalies	Kereba	Inland Baining	Gazelle	16924339.49	-485984.1113
28	-	24-Nov-18	Rabaul Provincial Hospital	Hospital	Male	Imperforate anus	Gastrointestinal system, abdominal anomalies	Rakunai	Central Gazelle	Gazelle	16934570.74	-476163.5935
29	-	27-Nov-18	Tapipipi Health Centre	Health Centre	Male	Microcephaly	Central nervous system, head, and neck anomalies	Balanataman	Raluana	Kokopo	16945314.13	-482537.4244
30	-	29-Nov-18	St Mary's Hospital Vunapope	Hospital	Female	Down syndrome	Chromosomal or identifiable genetic syndromes	Ralubang	Bitapaka Rural	Kokopo	16955397.57	-493231.6713
31	-	30-Nov-18	Rabaul Provincial Hospital	Hospital	Male	Congenital heart disease	Cardiothoracic anomalies	Poio	Melkoi	Pomio	16808713.03	-665602.0017
32	-	11-Dec-18	St Mary's Hospital Vunapope	Hospital	Male	Congenital heart disease	Cardiothoracic anomalies	Rapitok 1	Toma-Vunadidir	Gazelle	16934306.77	-485717.0166

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33	-	11-Dec-18	St Mary's Hospital Vunapope	Hospital	Male	Congenital heart disease	Cardiothoracic anomalies	Mungou	Sinivit	Pomio	16961820.91	-522698.5084
34	-	11-Dec-18	Rabaul Provincial Hospital	Hospital	Male	Congenital heart disease	Cardiothoracic anomalies	Palmmal	Central-Inland Pomio	Pomio	16864601.38	-628440.5328
35	-	11-Dec-18	Rabaul Provincial Hospital	Hospital	Female	Congenital heart disease	Cardiothoracic anomalies	Palmmal	Central-Inland Pomio	Pomio	16864410.28	-629128.4617
36	-	17-Dec-18	Napapar Health Subcentre	Health Subcentre	Male	Phimosis	Renal and genitourinary anomalies	Tavilo	Central Gazelle	Gazelle	16924385.64	-479488.5598
37	-	22-Dec-18	St Mary's Hospital Vunapope	Hospital	Male	Congenital heart disease	Cardiothoracic anomalies	Ralubang	Bitapaka Rural	Kokopo	16954728.75	-493441.8703
38	-	14-Jan-19	St Mary's Hospital Vunapope	Hospital	Male	Congenital heart disease	Cardiothoracic anomalies	Ganai	Bitapaka Rural	Kokopo	16957892.18	-499650.9794
39	1	16-Jan-19	Rabaul Provincial Hospital	Hospital	Female	Down syndrome	Chromosomal or identifiable genetic syndromes	Rababat	Livuan-Reimber	Gazelle	16923567.99	-467417.3288
40	-	23-Jan-19	St Mary's Hospital Vunapope	Hospital	Female	Congenital heart disease	Cardiothoracic anomalies	Karavia	Kokopo-Vunamami	Kokopo	16946454.66	-482258.4267
41	2	25-Jan-19	Rabaul Provincial Hospital	Hospital	Female	Congenital heart disease	Cardiothoracic anomalies	Rabaul town	Rabaul	Rabaul	16938827.9	-467852.5881
42	-	28-Jan-19	Napapar Health Subcentre	Health Subcentre	Female	Omphalocele	Gastrointestinal system, abdominal anomalies	Napapar 1	Central Gazelle	Gazelle	16934475.19	-482794.4172
43	3	09-Feb-19	Rabaul Provincial Hospital	Hospital	Female	Congenital heart disease	Cardiothoracic anomalies	Kokopo Town	Kokopo-Vunamami	Kokopo	16950754.12	-483834.8975
44	-	12-Feb-19	St Mary's Hospital Vunapope	Hospital	Male	Tracheo-oesophageal fistula	Cardiothoracic anomalies	Napapar 1	Central Gazelle	Gazelle	16935277.77	-482354.9101
45	4	12-Feb-19	Rabaul Provincial Hospital	Hospital	Male	Congenital heart disease	Cardiothoracic anomalies	Taranga	Livuan-Reimber	Gazelle	16932768.85	-472576.688

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46	5	13-Feb-19	Rabaul Provincial Hospital	Hospital	Female	Down syndrome	Chromosomal or identifiable genetic syndromes	Gunanba	Kokopo-Vunamami	Kokopo	16942793.2	-485217.1317
47	6	14-Feb-19	Rabaul Provincial Hospital	Hospital	Female	Isolated cleft soft palate	Central nervous system, head, and neck anomalies	Napapar 1	Central Gazelle	Gazelle	16934647.17	-482450.4552
48	7	18-Feb-19	Rabaul Provincial Hospital	Hospital	Female	Isolated cleft palate	Central nervous system, head, and neck anomalies	Pomio	Central-Inland Pomio	Pomio	16867467.75	-615522.758
49	-	17-Feb-19	St Mary's Hospital Vunapope	Hospital	Male	Congenital heart disease	Cardiothoracic anomalies	Malakuna 4	Kokopo-Vunamami	Kokopo	16943989.63	-489949.6935
50	8	03-Mar-19	Rabaul Provincial Hospital	Hospital	Male	Congenital heart disease	Cardiothoracic anomalies	Rabaul town	Rabaul	Rabaul	16939909.84	-467391.6281
51	-	16-Mar-19	St Mary's Hospital Vunapope	Hospital	Female	Congenital heart disease	Cardiothoracic anomalies	Napapar 3	Central Gazelle	Gazelle	16932220.33	-483348.5783
52	9	19-Mar-19	Rabaul Provincial Hospital	Hospital	Female	Undiagnosed syndrome	Chromosomal or identifiable genetic syndromes	Warangoi	Sinivit	Pomio	16937184.21	-501243.6683
53	-	27-Mar-19	St Mary's Hospital Vunapope	Hospital	Male	Hydrocephalus	Central nervous system, head, and neck anomalies	Ramale	Livuan-Reimber	Gazelle	16932606.43	-475395.2267
54	10	28-Feb-19	Warangoi Rural Hospital	Hospital	Male	Congenital heart disease	Cardiothoracic anomalies	Warangoi	Sinivit	Pomio	16937547.28	-500861.4882
55	-	19-Apr-19	St Mary's Hospital Vunapope	Hospital	Male	Undiagnosed syndrome	Chromosomal or identifiable genetic syndromes	Mile	Central-Inland Pomio	Pomio	16851869.77	-593783.1517
56	11	26-Apr-19	Rabaul Provincial Hospital	Hospital	Male	Microcephaly	Central nervous system, head, and neck anomalies	Takubar	Kokopo-Vunamami	Kokopo	16953132.65	-485788.3404
57	-	25-Apr-19	Keravat Rural Hospital	Hospital	Female	Congenital heart disease	Cardiothoracic anomalies	Keravat	Central Gazelle	Gazelle	16925104.18	-484369.4542

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58	-	27-Apr-19	Napapar Health Subcentre	Health Centre	Female	Laryngomalacia	Central nervous system, head, and neck anomalies	Tagitagi 1	Toma-Vunadidir	Gazelle	16939428.02	-486252.0724
59	12	09-May-19	Rabaul Provincial Hospital	Hospital	Female	Microcephaly	Central nervous system, head, and neck anomalies	Warongoi	Sinivit	Pomio	16938502.73	-500957.0332
60	-	16-May-19	St Mary's Hospital Vunapope	Hospital	Male	Undiagnosed syndrome	Chromosomal or identifiable genetic syndromes	Uvol	Melkoi	Pomio	16808865.91	-669347.4174
61	13	12-May-19	Rabaul Provincial Hospital	Hospital	Male	Undiagnosed syndrome	Chromosomal or identifiable genetic syndromes	Vunakalkalulu	Livuan-Reimber	Gazelle	16933370.78	-472729.5579
62	-	25-May-19	St Mary's Hospital Vunapope	Hospital	Female	Congenital heart disease	Cardiothoracic anomalies	Nakukur	Duke of York	Kokopo	16967182.72	-463320.6501
63	-	19-Jun-19	St Mary's Hospital Vunapope	Hospital	Male	Undiagnosed syndrome	Chromosomal or identifiable genetic syndromes	Gunanba	Kokopo-Vunamami	Kokopo	16943041.61	-485274.4579
64	-	13-Jun-19	St Mary's Hospital Vunapope	Hospital	Female	Patau syndrome	Chromosomal or identifiable genetic syndromes	Kokopo Town	Kokopo-Vunamami	Kokopo	16950075.76	-484092.8655
65	-	30-Jun-19	St Mary's Hospital Vunapope	Hospital	Male	Imperforate anus	Gastrointestinal system, abdominal anomalies	Nabual	Duke of York	Kokopo	16975628.96	-464925.8174
66	14	08-Jun-19	Rabaul Provincial Hospital	Hospital	Male	Isolated cleft soft palate	Central nervous system, head, and neck anomalies	Napapar 2	Central Gazelle	Gazelle	16933997.47	-483405.9053
67	-	10-Jul-19	St Mary's Hospital Vunapope	Hospital	Female	Undiagnosed syndrome	Chromosomal or identifiable genetic syndromes	Raniolo	Kokopo-Vunamami	Kokopo	16950256.78	-485415.72
68	15	01-Jul-19	Rabaul Provincial Hospital	Hospital	Female	Treacher Collin syndrome	Chromosomal or identifiable genetic syndromes	Nonga	Balanataman	Rabaul	16936848.33	-464563.3889

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69	16	11-Jul-19	Rabaul Provincial Hospital	Hospital	Female	Pierre Robin sequence	Central nervous system, head, and neck anomalies	Ralimut	Livuan-Reimber	Gazelle	16931784.75	-474334.6918
70	17	08-Jul-19	Rabaul Provincial Hospital	Hospital	Male	Congenital heart disease	Cardiothoracic anomalies	Matupit	Kombiu Rural	Rabaul	16941392.68	-472682.6786
71	18	23-Jul-19	Rabaul Provincial Hospital	Hospital	Female	Duodenal Atresia	Gastrointestinal system, abdominal anomalies	Kabakada	Livuan-Reimber	Gazelle	16931536.34	-468329.7546
72	-	27-Jul-19	St Mary's Hospital Vunapope	Hospital	Male	Congenital heart disease	Cardiothoracic anomalies	Tokua	Bitapaka Rural	Kokopo	16963394.55	-482325.3072
73	-	18-Aug-19	St Mary's Hospital Vunapope	Hospital	Male	Congenital heart disease	Cardiothoracic anomalies	Takabur	Kokopo-Vunamami	Kokopo	16953017.99	-486285.1676
74	-	20-Aug-19	St Mary's Hospital Vunapope	Hospital	Female	Cervical meningocele	Central nervous system, head, and neck anomalies	Vunamami	Kokopo-Vunamami	Kokopo	16947459.84	-483243.517
75	19	24-Aug-19	Rabaul Provincial Hospital	Hospital	Female	Down syndrome	Chromosomal or identifiable genetic syndromes	Ravat	Raluana	Kokopo	16941224.8	-484734.9597
76	-	31-Aug-19	St Mary's Hospital Vunapope	Hospital	Female	Tracheo-oesophageal fistula	Cardiothoracic anomalies	Pomio	Central-Inland Pomio	Pomio	16866588.73	-614261.5551
77	-	10-Sep-19	St Mary's Hospital Vunapope	Hospital	Male	Hydrocephalus	Central nervous system, head, and neck anomalies	Vunadidir	Toma-Vunadidir	Gazelle	16937440.67	-484302.9407
78	20	06-Sep-19	Rabaul Provincial Hospital	Hospital	Male	Congenital heart disease	Cardiothoracic anomalies	Tau	Bitapaka Rural	Kokopo	16956219.25	-489104.1269
79	21	11-Sep-19	Rabaul Provincial Hospital	Hospital	Male	Syndactyly	Musculoskeletal, limb anomalies	Ramale	Kokopo-Vunamami	Kokopo	16950868.78	-490083.4547
80	-	01-Sep-19	Lassul Health Centre	Health Centre	Male	Imperforate Anus	Gastrointestinal system, abdominal anomalies	Open Bay	Lassul-Baining	Gazelle	16887107.41	-535288.4951

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81	-	14-Sep-19	Papatava Health Centre	Health Centre	Female	Caecum stenosis	Gastrointestinal system, abdominal anomalies	Wairiki 1	Toma-Vunadidir	Gazelle	16940803.9	-491201.3378
82	-	03-Oct-19	Keravat Rural Hospital	Hospital	Female	Congenital Rubella Syndrome	Other congenital malformation syndromes affecting multiple systems	Usunet	Inland Baining	Gazelle	16924668.06	-493328.9132
83	-	04-Oct-19	Keravat Rural Hospital	Hospital	Male	Bilateral hydrocoele	Renal and genitourinary anomalies	Rabagi	Toma-Vunadidir	Gazelle	16937478.89	-487169.3108
84	22	28-Oct-19	Rabaul Provincial Hospital	Hospital	Male	Congenital heart disease	Cardiothoracic anomalies	Raunsepna	Inland Baining	Gazelle	16897357.4	-496111.9525
85	23	16-Oct-19	Rabaul Provincial Hospital	Hospital	Male	Gastroschisis	Gastrointestinal system, abdominal anomalies	Mandrabit	Lassul-Baining	Gazelle	16894139.6	-528179.8725
86	24	22-Oct-19	Rabaul Provincial Hospital	Hospital	Male	Down syndrome	Chromosomal or identifiable genetic syndromes	Napapar 1	Central Gazelle	Gazelle	16935067.57	-482163.8201
87	25	26-Oct-19	Rabaul Provincial Hospital	Hospital	Female	Cleft lip and cleft palate	Central nervous system, head, and neck anomalies	Viviran 1	Toma-Vunadidir	Gazelle	16939007.62	-491373.3204
88	-	02-Nov-19	Keravat Rural Hospital	Hospital	Female	Congenital heart disease	Cardiothoracic anomalies	Keravat NARI	Central Gazelle	Gazelle	16923345.99	-481760.9411
89	26	13-Nov-19	Rabaul Provincial Hospital	Hospital	Female	Undiagnosed syndrome	Chromosomal or identifiable genetic syndromes	Ratavul	Balanataman	Rabaul	16936599.91	-465977.455
90	-	18-Nov-19	St Mary's Hospital Vunapope	Hospital	Male	Umbilical hernia	Gastrointestinal system, abdominal anomalies	Tau	Bitapaka Rural	Kokopo	16956200.14	-489753.8329
91	27	07-Nov-19	Rabaul Provincial Hospital	Hospital	Male	Tracheo-oesophageal fistula	Cardiothoracic anomalies	Vunatagia	Raluana	Kokopo	16944396.89	-480339.8892

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92	28	21-Nov-19	Rabaul Provincial Hospital	Hospital	Male	Congenital heart disease	Cardiothoracic anomalies	Totovel	Livuan-Reimber	Gazelle	16930580.9	-473331.4831
93	-	29-Nov-19	Lassul Health Centre	Health Centre	Male	Imperforate anus	Gastrointestinal system, abdominal anomalies	Lassul	Lassul-Baining	Gazelle	16889897.44	-470202.5685
94	-	06-Dec-19	Keravat Rural Hospital	Hospital	Male	Undiagnosed syndrome	Chromosomal or identifiable genetic syndromes	Napapar 4	Central Gazelle	Gazelle	16931226.66	-484495.1184
95	-	09-Dec-19	Rabaul Provincial Hospital	Hospital	Male	Congenital heart disease	Cardiothoracic anomalies	lawakaka	Balanataman	Rabaul	16935491.59	-469149.5494
96	-	25-Dec-19	Napapar Health Subcentre	Health Centre	Male	Diaphragmatic hernia	Gastrointestinal system, abdominal anomalies	Napapar 4	Central Gazelle	Gazelle	16931112.01	-484667.0994
97	-	30-Dec-19	Palmalmal Rural Hospital	Hospital	Male	Imperforate anus	Gastrointestinal system, abdominal anomalies	Pomio	Central-Inland Pomio	Pomio	16867964.58	-615599.1945
98	-	12-Dec-19	Rabaul Provincial Hospital	Hospital	Female	Congenital heart disease	Cardiothoracic anomalies	Warangoi	Sinivit	Pomio	16937986.79	-500154.4551
99	-	19-Jan-20	Rabaul Provincial Hospital	Hospital	Female	Anencephaly	Central nervous system, head, and neck anomalies	Kuraip	Livuan-Reimber	Gazelle	16934784.82	-471774.121
100	-	03-Feb-20	Rabaul Provincial Hospital	Hospital	Female	Hydrocephalus	Central nervous system, head, and neck anomalies	Tanaka	Toma-Vunadidir	Gazelle	16939733.77	-484570.4685
101	-	08-Feb-20	Rabaul Provincial Hospital	Hospital	Male	Laryngomalacia	Central nervous system, head, and neck anomalies	lawakaka	Balanataman	Rabaul	16935013.87	-468920.2413
102	-	04-Feb-20	St Mary's Hospital Vunapope	Hospital	Female	Cleft lip and palate	Central nervous system, head, and neck anomalies	Vunapope Compound	Kokopo-Vunamami	Kokopo	16953698.84	-485527.0111
103	-	11-Feb-20	Napapar Health Subcentre	Health Centre	Male	Congenital heart disease	Cardiothoracic anomalies	Vunakabi	Toma-Vunadidir	Gazelle	16937555.33	-484417.5955

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104	-	03-Mar-20	Napapar Health Subcentre	Health Centre	Male	Other skeletal dysplasia	Musculoskeletal, limb anomalies	Vunadidir	Toma-Vunadidir	Gazelle	16936294.12	-485067.306
105	-	29-Mar-20	Rabaul Provincial Hospital	Hospital	Female	Congenital heart disease	Cardiothoracic anomalies	Warongoi	Sinivit	Pomio	16937929.46	-501644.9573
106	-	06-Mar-20	Napapar Health Subcentre	Health Centre	Male	Patau syndrome	Chromosomal or identifiable genetic syndromes	Ratavul	Toma-Vunadidir	Gazelle	16935567.98	-484073.631
107	-	May-20	Rabaul Provincial Hospital	Hospital	Male	Hypospadias	Renal and genitourinary anomalies	Tinganagalip	Central Gazelle	Gazelle	16934446.98	-479664.9958
108	-	18-May-20	Warangoi Rural Hospital	Hospital	Female	Patau syndrome	Chromosomal or identifiable genetic syndromes	Sikut - Talvat	Kombiu Rural	Rabaul	16946358.53	-501279.9062
109	-	12-May-20	Rabaul Provincial Hospital	Hospital	Female	Undiagnosed syndrome	Chromosomal or identifiable genetic syndromes	Kikitabu	Livuan-Reimber	Gazelle	16931039.51	-475309.2374
110	-	23-May-20	Rabaul Provincial Hospital	Hospital	Female	Congenital heart disease	Cardiothoracic anomalies	Malaguna 1	Balanataman	Rabaul	16938128.64	-468538.0613
111	-	21-May-20	St Mary's Hospital Vunapope	Hospital	Male	Microcephaly	Central nervous system, head, and neck anomalies	Takubar	Kokopo-Vunamami	Kokopo	16951986.12	-486055.8627
112	-	31-May-20	Napapar Health Subcentre	Health Centre	Female	Cleft lip and cleft palate	Central nervous system, head, and neck anomalies	Vunakanau	Central Gazelle	Gazelle	16929286.85	-481582.5959
113	-	02-Jun-20	Rabaul Provincial Hospital	Hospital	Male	Congenital heart disease	Cardiothoracic anomalies	Kerevat Town	Central Gazelle	Gazelle	16924328.31	-482832.6352
114	-	29-Jun-20	Rabaul Provincial Hospital	Hospital	Male	Adrenogenital syndrome, congenital heart disease, micropenis, hypospadias	Other congenital malformation syndromes affecting multiple systems	Vunagogo	Central Gazelle	Gazelle	16934322.32	-480386.6829

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115	-	23-Jun-20	Rabaul Provincial Hospital	Hospital	Male	Craniofacial Anomaly - Cleft palate, microtia, facial Hypoplasia	Central nervous system, head, and neck anomalies	Malakur	Central-Inland Pomio	Pomio	16858333.58	-621140.8435
116	-	11-Jul-20	Rabaul Provincial Hospital	Hospital	Female	Hydrocephalus	Central nervous system, head, - and neck anomalies	Vunamurmur	Raluana	Kokopo	16942352.23	-480664.7422
117	-	08-Jul-20	Rabaul Provincial Hospital	Hospital	Female	Anencephaly	Central nervous system, head, and neck anomalies	Raluana	Raluana	Kokopo	16944893.73	-479709.2921
118	-	11-Jul-20	Paparatava Health Centre	Health Centre	Female	Colon atresia, urinary bladder stenosis	Other congenital malformation syndromes affecting multiple systems	Wairiki 2	Toma-Vunadidir	Gazelle	16941377.17	-492634.5129
119	-	19-Jul-20	Rabaul Provincial Hospital	Hospital	Male	Laryngomalacia	Central nervous system, head, and neck anomalies	Uvol	Melkoi	Pomio	16811694.07	-670417.5326
120	-	26-Jul-20	St Mary's Hospital Vunapope	Hospital	Female	Imperforate anus	Gastrointestinal system, abdominal anomalies	Kokopo City	Kokopo-Vunamami	Kokopo	16949034.34	-482717.0364
121	-	30-Aug-20	Rabaul Provincial Hospital	Hospital	Female	Incomplete Pentalogy of Cantrell - ectopia cordis, Patau syndrome, craniomeningocele, sternal defect,	Other congenital malformation syndromes affecting multiple systems	Malaguna 1	Balanataman	Rabaul	16937975.76	-468576.2793
122	-	04-Sep-20	St Mary's Hospital Vunapope	Hospital	Male	Down syndrome	Chromosomal or identifiable genetic syndromes	Ngatur	Raluana	Kokopo	16941874.5	-484333.6706
123	-	07-Sep-20	St Mary's Hospital Vunapope	Hospital	Male	Cleft lip and palate	Central nervous system, head, and neck anomalies	Kabakaul	Kokopo-Vunamami	Kokopo	16956792.17	-483728.0979

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124	-	10-Sep-20	Rabaul Provincial Hospital	Hospital	Male	Microphthalmia	Central nervous system, head, and neck anomalies	Vunapaka	Livuan-Reimber	Gazelle	16929673.24	-472977.9714
125	-	15-Sep-20	Tapipipi Health Centre	Health Centre	Male	Anencephaly	Central nervous system, head, and neck anomalies	Ralalar	Raluana	Kokopo	16939772.51	-481620.1923
126	-	18-Sep-20	Rabaul Provincial Hospital	Hospital	Female	Down syndrome	Chromosomal or identifiable genetic syndromes	Lungalunga	Livuan-Reimber	Gazelle	16918924.57	-469089.3434
127	-	18-Sep-20	St Mary's Hospital Vunapope	Hospital	Female	Diaphragmatic hernia	Gastrointestinal system, abdominal anomalies	Rapitok 4	Toma-Vunadidir	Gazelle	16934459.65	-488010.1127
128	-	18-Sep-20	St Mary's Hospital Vunapope	Hospital	Female	Cleft lip and cleft palate	Central nervous system, head, and neck anomalies	Bitapaka	Bitapaka Rural	Kokopo	16953783.75	-491090.1464
129	-	21-Sep-20	Paparatava Health Centre	Health Centre	Male	Microcephaly	Central nervous system, head, and neck anomalies	Viviran 1	Toma-Vunadidir	Gazelle	16938357.91	-492902.0511
130	-	03-Oct-20	Rabaul Provincial Hospital	Hospital	Female	Congenital heart disease	Cardiothoracic anomalies	Rieit	Sinivit	Pomio	16932426.07	-507626.075
131	-	21-Oct-20	Keravat Rural Hospital	Hospital	Female	Osteogenesis imperfecta	Musculoskeletal, limb anomalies	Malasaet	Inland Baining	Gazelle	16909013.97	-497258.5006
132	-	22-Oct-20	Rabaul Provincial Hospital	Hospital	Female	Tracheo-esophageal fistula	Cardiothoracic anomalies	Nonga Village	Balanataman	Rabaul	16936829.22	-464811.8059
133	-	23-Oct-20	Rabaul Provincial Hospital	Hospital	Male	Cleft lip and cleft palate	Central nervous system, head, and neck anomalies	Rieit	Sinivit	Pomio	16931203.09	-507989.146
134	-	21-Oct-20	Rabaul Provincial Hospital	Hospital	Male	Undiagnosed syndrome	Chromosomal or identifiable genetic syndromes	Nonga	Balanataman	Rabaul	16937039.42	-463665.2658
135	-	28-Oct-20	Rabaul Provincial Hospital	Hospital	Male	Diaphragmatic hernia	Gastrointestinal system,	Ratavul	Balanataman	Rabaul	16936504.37	-465824.583

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							abdominal anomalies					
136	-	05-Nov-20	Paparatava Health Centre	Health Centre	Male	Undiagnosed syndrome	Chromosomal or identifiable genetic syndromes	Wairiki 1	Toma-Vunadidir	Gazelle	16941854.89	-491354.2098
137	-	24-Nov-20	Rabaul Provincial Hospital	Hospital	Female	Imperforate anus	Gastrointestinal system, abdominal anomalies	Wairiki 1	Toma-Vunadidir	Gazelle	16941491.82	-491946.5889