

Mortality rates and the utilization of health services during terminal illness in the Asaro Valley, Eastern Highlands Province, Papua New Guinea

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SUMMARY

Between 1980 and 1989 we carried out fortnightly demographic surveillance in a random sample of people living in Goroka town, periurban areas and rural areas in the Lowa and Asaro Census Divisions, all within 1½ hours' drive of the town in the Asaro Valley, Eastern Highlands Province. Cause of death was determined by verbal autopsy supplemented by any available health service information. Crude death and birth rates were 10 and 32 per 1000 person-years, respectively, in 59,906 person-years at risk. The standardized mortality ratio increased with increasing distance from town. Life expectancy at birth was 57 years for males and 55 years for females. The stillbirth rate was 19 per 1000 births, neonatal and infant mortality 21 and 60 per 1000 livebirths, respectively, and 1-4-year mortality 9 per 1000 person-years. Maternal mortality was 3 per 1000 births. Neonatal and infant mortality were respectively 7 and 3 times as high in Asaro Census Division as in Goroka town. Acute lower respiratory tract infections accounted for 22% of all deaths, chronic obstructive lung disease 10%, trauma 8% and gastroenteritis/dysentery 7%. 76% of deaths occurred at home and 44% of people who died had no treatment during their terminal illness. Health services were used most frequently by urban dwellers and by the young. To reduce mortality, a political commitment to provide functioning health services in rural areas is needed; regular supervision of health staff, ensuring the safety of staff and their families, availability of antibiotics as near people's homes as possible and regular mobile maternal and child health clinics are essential. Health education should include recognition of signs of severe disease and the importance of seeking treatment early. In view of high maternal and neonatal mortality, user fees should be waived for pregnant women.

Introduction

Information on levels of mortality and causes of death is critical for the development of national health policy, program planning and evaluation. Most mortality data available in Papua New Guinea (PNG) are from health institutional records, which only provide information about those who die in a health facility. There is no vital registration of births and deaths in PNG. Data on cause of death in PNG are generally obtained through death certificates completed by medical personnel who record the underlying and immediate

causes of death. These data are not necessarily representative of mortality as a whole since the many undocumented deaths occurring outside health institutions are not included.

In 1979 the PNG Institute of Medical Research established a population-based study in the Asaro Valley of the Eastern Highlands Province to:

- 1) determine levels of mortality and morbidity as part of an acute respiratory infection sentinel research unit,
- 2) determine the causes of mortality in the community,

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- 3) identify risk factors and
- 4) evaluate interventions, specifically pneumococcal and *Haemophilus influenzae* vaccines in children.

In this paper we describe the method of demographic surveillance, the levels and causes of mortality and the medical treatment sought at time of death in a rural and urban highlands population.

Setting

The study took place in the Asaro and Lowa Census Divisions (CDs) and Goroka town situated in the Asaro Valley, which lies six degrees south of the equator. People in the study area live between 1500 and 1900 metres above sea level. Asaro CD is the most distant from Goroka town but all villages in the study area are within 38 kilometres and 1½ hours' drive of Goroka town (Figure 1). There is a clear wet and dry season with 75% of the rain falling between November and April annually. Diurnal temperatures range between 16°C and 30°C with little seasonal variation.

In Goroka town people live in houses made

of permanent material, usually with windows, separate kitchen and bedroom and at least one wage earner per household. In the rural areas, people live in hamlets, grouped together into villages; their houses are made of wood and woven cane-grass with thatched roofs. Houses with windows for ventilation are uncommon in the rural areas. Houses usually have one central place for cooking and sleeping. Dried wood is commonly used for making fire for cooking or for warmth whereas in the urban area electricity, gas and kerosine are used. People are primarily subsistence farmers, but earn cash through smallholder production of coffee, employment on plantations and marketing of garden produce. The staple crop is sweet potato. Pig ownership is universal in the Asaro Valley (except among Seventh Day Adventists) and represents wealth and prestige.

Three main local languages ('tokples') - Asaro, Gahuku and Siane - are spoken in the study area. There has also been considerable in-migration from neighbouring Simbu Province, particularly into Asaro CD, and inhabitants of Goroka town come from all over the country. Both local landowners and immigrants live in the periurban areas. Melanesian Pidgin is widely spoken

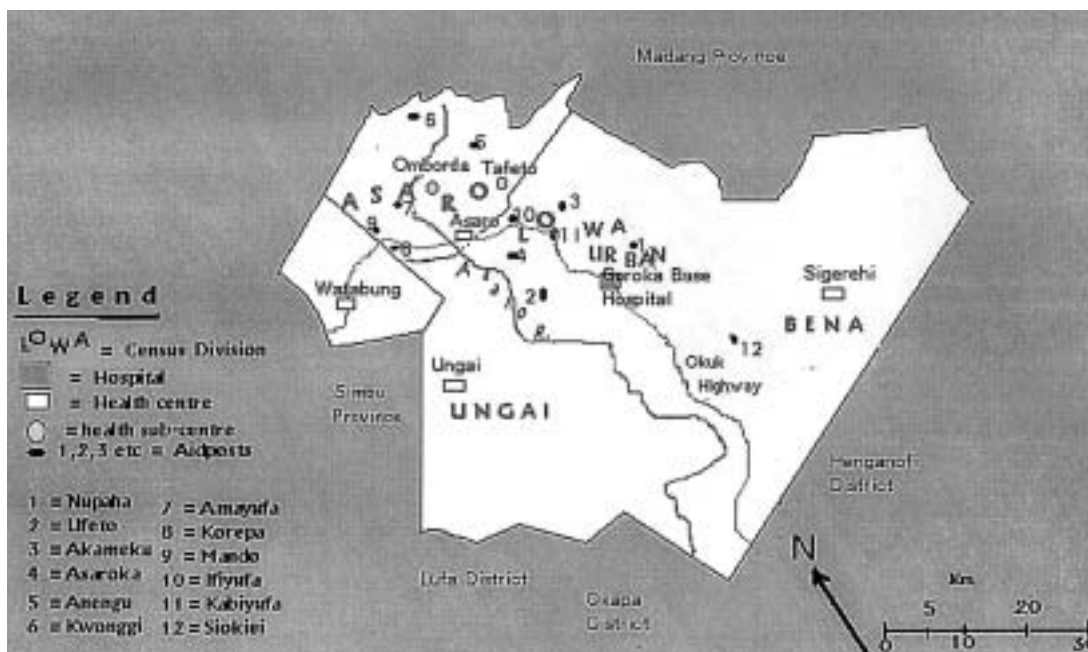


Figure 1. Map of the study area including urban Goroka town, periurban area, and Lowa and Asaro Census Divisions, with the health facilities covering the population under surveillance.

throughout the valley and was the main avenue of communication between non-tokples speakers and local inhabitants. However, most of the field workers belonged to one of the tokples groups, which greatly facilitated our communication with the local people.

Goroka Base Hospital (GBH) is the main hospital for the province. In addition the study area was served by a government health centre at Asaro station and two health subcentres at Omborda and Tafeto in Asaro CD run by the Salvation Army and Catholic Church, respectively. Omborda Health Subcentre was totally destroyed during interclan fighting in 1989. Thirteen aid posts staffed by aid post orderlies existed in the study area. Three of these aid posts had closed down before this study was completed. Since road access to Goroka was relatively good in the monitored area, many people bypassed their local aid posts and sought treatment either at the more distant health centres or, more commonly, at GBH.

Methods

The study took place in a random sample of villages and sections of Goroka town (1,2). The rural area was stratified into 5 strata by census division and village population size, with each village being a cluster, and probability proportional sampling was done according to the number of children in the villages until a total of 200 children was reached in each stratum. In Goroka town, probability proportional sampling of households in high, medium and low cost housing strata was done such that 15% of the population in each stratum was sampled.

Demographic surveillance was carried out fortnightly between 1980 and 1986, then weekly between 1986 and April 1989 (while studying the epidemiology of diarrhoeal disease) and then again fortnightly until April 1990.

Village and town reporters with a minimum of primary school education, living in the area and having affiliations with the people to be monitored, were employed after consultation with local leaders. Reporters were trained in methods of data collection by health extension

officers (HEOs) and nurses, who subsequently supervised them both in the office and in the field. Each supervisor had to oversee the work of 7-8 reporters. On average, between 1980 and 1986, each reporter monitored 400 people, thereafter 216; the average number of people seen daily by each reporter was 65 until 1986, thereafter 54. While most reporters were male, in the later years female reporters were successfully employed.

Each household was visited on the same assigned day each fortnight (or week) to collect information on migrations, marriages, divorces, births, deaths, new entrants into the study area and permanent movement out of the study area. Censuses to update demographic information were carried out annually and when required (for example at times of mass in- or out-migration or relocation of hamlets) by field supervisors together with reporters. During each census a sketch map of each hamlet was made, and the position was noted of all houses and other buildings and any natural or man-made boundaries such as roads, streams or fences. Each house was allocated a number, which was marked on the map, on the house and in the household register held by reporters.

Each person was assigned a unique identification number; a social number was also allocated which indicated hamlet of residence, family and position within the family (eg, head of household, first or second wife, first child of first wife, adopted child etc) and this number could change during the course of the study with changes in status (eg, through marriage, adoption, movement from one hamlet to another). Dates of birth for those without a written record of date of birth were estimated using a calendar of events and ranking within the household and hamlet. Reporters reported all demographic events monthly to office staff who then updated demographic information on computer files.

As soon as appropriate after a death occurred, a nurse or HEO visited relatives who were present during the person's terminal illness to compile a full report of circumstances leading to death. Open-ended questions were asked, followed by enquiries as to the presence and duration of specific symptoms (with

particular reference to respiratory and gastrointestinal disorders) which were laid out in a standardized questionnaire; relatives were also asked what medical treatment was sought and where. These verbal autopsies were supplemented with any information available from health services. A final diagnosis for each death was assigned by an epidemiologist using a Classification of Symptom Complexes for Lay Reporting developed by Ian D. Riley for population-based surveys in PNG, based on the 9th revision of the International Classification of Diseases (3). The standard death certificate format was used with immediate, underlying and associated causes of death recorded. Only the underlying causes of death are reported here.

Analysis

Data were entered on computer files and error checking programs run prior to analysis. The area under surveillance was divided into four geographical areas: Goroka town, periurban areas immediately adjacent to the town located in Lowa CD, rural areas of Lowa CD and Asaro CD. Mortality rates were computed using person-years at risk as the denominator, which takes into account periods when members of the monitored population were not under demographic surveillance. Standard statistical tests for comparison between proportions were used (4). To allow for differences in age structure of populations in urban and rural areas, indirect standardization (using the total population as the standard) was used to calculate the standardized mortality ratio (4). Life expectancy was determined using MortPak-Lite (5).

Results

Age and sex distribution of the population and crude demographic rates

The mid-year de jure population under surveillance rose from 7021 in 1980 to 8840 in 1989; a total of 59,906 person-years at risk (pyr) were monitored. 72% of the monitored population lived in the rural areas of the Lowa (21%) and Asaro (51%) CDs, and 16% and 12% were in Goroka town and the periurban areas, respectively. 14% of the population at

risk were under 5 years of age, 21% of whom were under 1 year old. The male:female ratio was 111:100 at birth and 106:100 for the total population. Between 1980 and 1989 there were 1875 livebirths, 36 stillbirths and 582 deaths. Thus the crude birth rate (CBR) was 32/1000 pyr, crude death rate (CDR) 10/1000 pyr and rate of natural increase (CBR - CDR) 2.2%. Life expectancy at birth was 57 and 55 years for males and females, respectively.

The population of Goroka town is generally younger than the rural population and hence the town has a higher CBR and lower CDR: 20% of person-years in Goroka were under the age of 5 years and 4% over the age of 44 years while equivalent figures in rural areas were 12% and 19%, respectively. The standardized mortality ratio increased with increasing remoteness, from 0.62 in Goroka town to 1.24 in the Asaro CD. Thus, the overall likelihood of death in the more remote Asaro CD was twice that in Goroka town.

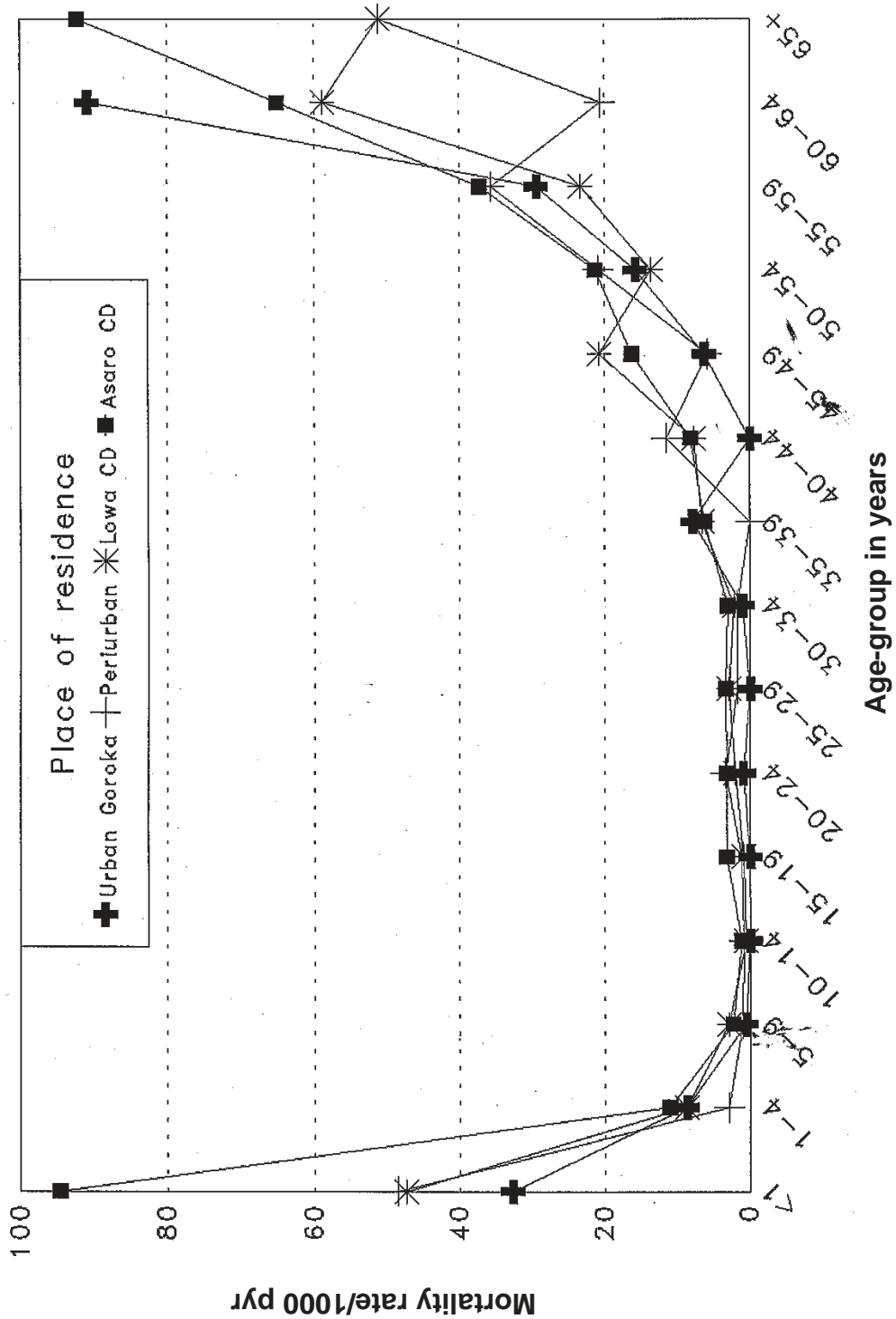
Age-specific mortality

Figure 2 shows the age-specific mortality rates by place of residence. Mortality in the young and the elderly was higher in the Asaro CD than elsewhere. In children, mortality fell rapidly after the first year of life (65/1000 pyr or 60/1000 livebirths) to 21/1000 pyr in the second year of life, 10/1000 in the third year and 3/1000 in the fourth and fifth year.

Infant mortality

The overall infant mortality rate (IMR) was 60/1000 livebirths (Figure 3). Mortality was higher in boys (63 deaths, 64/1000 livebirths) than girls (49 deaths, 55/1000 livebirths) during the first year of life, though the difference was not statistically significant. 21% (23/112) of all infant deaths occurred during the first week of life, 40 (36%) during the neonatal period and 87 (78%) during the first 6 months; 66% of all deaths under the age of 5 years occurred during the first 12 months, 51% during the first 6 months of life.

The stillbirth rate was very low in Goroka town and highest in the periurban area, though not significantly higher than in the rural areas (Figure 3). Neonatal mortality in Asaro CD



CD = census division
pyr = person years at risk: there were 17 pyr age <1 year with unknown place of residence

Figure 2. Age-specific mortality rates/1000 pyr by place of residence, 1980-1989.

was 7 times higher (33/1000 livebirths) than in the urban area ($\chi^2 = 8.16, 1 \text{ df}, p < 0.01$) and twice as high as in the rural and periurban areas of Lowa CD ($\chi^2 = 3.06, 1 \text{ df}, p = 0.08$). Postneonatal mortality (28 days to 11 months of age) was almost twice as high in the more remote Asaro CD as elsewhere ($\chi^2 = 7.69, 1 \text{ df}, p < 0.01$). Overall, infant mortality was 1.4 times higher in the rural and periurban areas of Lowa CD than in Goroka town ($\chi^2 = 0.78, 1 \text{ df}, p > 0.05$) and 2.7 times higher in Asaro CD than in the town ($\chi^2 = 12.25, 1 \text{ df}, p < 0.001$). Under-5 mortality (deaths before the age of 5 years/1000 livebirths) was 91/1000 livebirths with no significant difference between boys and girls.

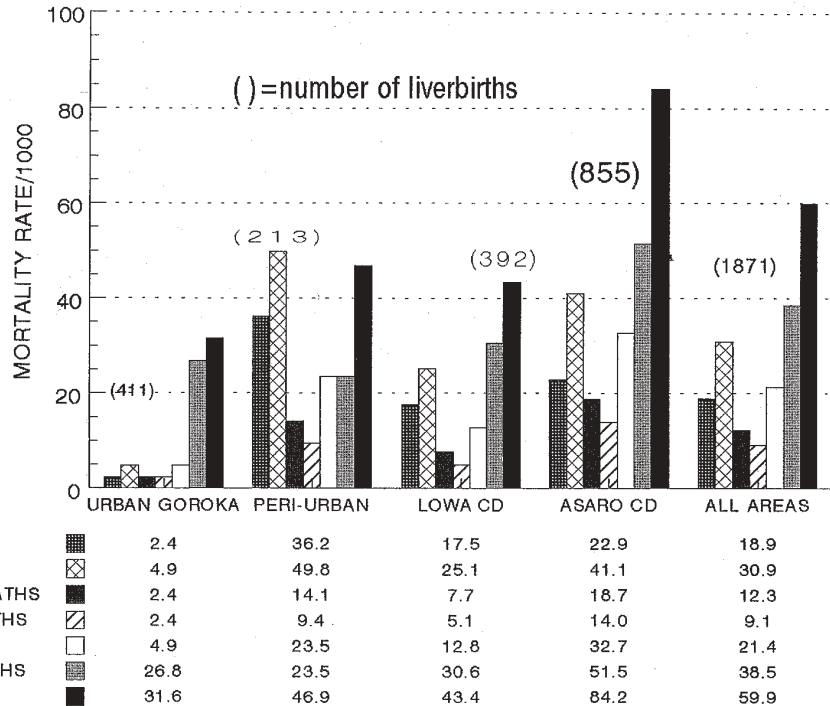
Cause-specific mortality

Acute lower respiratory tract infections (ALRI), defined as cough and breathlessness for less than 4 weeks with or without fever, accounted for 22% of all deaths and chronic obstructive lung disease (chronic cough and/or breathlessness for 6 months or more) for a further 10%; 16% of all deaths were from acute

or chronic abdominal conditions and 8% from trauma (Table 1). The cause of death could not be ascertained either by verbal autopsy or from health institution records for 10% of deaths. These were mainly adults over 60 years of age whose relatives tended to tell interviewers that the person had died of 'old age' or that their 'time was up'. In infancy, many children died of ill-defined neonatal causes in addition to the few who died with recognized congenital abnormalities. The maternal mortality rate was 3/1000 births (6/1911).

Trauma accounted for almost one-third of deaths in 15-29 year olds; the homicide rate for both sexes aged 15-44 years was 4/10000 pyr, while in older adults it was 2 and 9/10000 pyr for males and females, respectively.

Measles accounted for 2% of all deaths, 8% of deaths in children aged 1-4 years and 7% of infant deaths. 6 (43%) of the 14 deaths from measles occurred in the urban area and 8 (57%) occurred under one year of age. The number of deaths annually from measles varied markedly during the study with no deaths from



CD = Census division
 Note: Residence unknown for 4 births, none of whom died

Figure 3. Mortality rates at different ages in infancy by place of residence, 1980-1989.

TABLE 1

CAUSE- AND AGE-SPECIFIC MORTALITY RATES/1000 PYR IN THE ASARO VALLEY, 1980-1989

Cause of death	PYR	Age in years						Total	
		<1	1-4	5-14	15-29	30-44	45-59		60+
	1743	rate (n)	6427	15938	14817	11066	7730	2185	59906
ALRI	24.7 (43)	2.5 (16)	0.1 (1)	0.1 (1)	0.1 (2)	0.8 (9)	3.0 (23)	14.2 (31)	125 (21.5)
COLD	-	-	-	-	0.1 (1)	0.7 (8)	3.9 (30)	8.2 (18)	57 (9.8)
Other respiratory disease	4.6 (8)	0.6 (4)	-	-	0.3 (4)	0.5 (6)	2.8 (22)	4.1 (9)	53 (9.1)
Measles	4.6 (8)	0.8 (5)	0.1 (1)	-	-	-	-	-	14 (2.4)
Fevers ^b	1.1 (2)	0.6 (4)	0.3 (5)	0.5 (8)	0.5 (6)	1.4 (11)	-	0.5 (1)	37 (6.4)
Acute abdominal conditions ^c	1.7 (3)	2.5 (16)	-	-	0.2 (3)	0.3 (3)	2.1 (16)	9.2 (20)	61 (10.5)
Chronic abdominal conditions	0.6 (1)	0.2 (1)	-	-	0.1 (1)	0.4 (4)	1.2 (9)	6.9 (15)	31 (5.3)
Neonatal/congenital causes ^d	22.4 (39)	0.2 (1)	0.1 (2)	-	-	-	-	-	42 (7.2)
Trauma	1.1 (2)	0.5 (3)	0.4 (7)	0.7 (10)	0.5 (6)	1.9 (15)	0.5 (1)	0.5 (1)	44 (7.6)
Other causes	1.7 (3)	1.1 (7)	0.3 (5)	0.2 (3)	1.0 (11)	3.0 (23)	5.0 (11)	5.0 (11)	63 (10.8)
Cause unknown	1.7 (3)	0.3 (2)	0.1 (2)	0.1 (2)	0.1 (2)	0.3 (3)	1.9 (15)	12.8 (28)	55 (9.5)
Total	64.3 (112)	9.2 (59)	1.4 (23)	2.3 (34)	5.1 (56)	21.2 (164)	61.3 (134)	582 (100)	

PYR = person-years at risk

ALRI = acute lower respiratory tract infections

COLD = chronic obstructive lung disease

^a Percentage of all deaths

^b Fevers include malaria, meningitis, encephalitis, typhoid

^c Acute abdominal conditions include gastroenteritis, dysentery, pigbel

^d 8 deaths from congenital causes <1 year

measles in 1980-1981, 1983-1985 and 1989, but in 1987 measles mortality in infants rose to 21/1000 pyr (4 deaths/188 pyr).

Gastroenteritis and dysentery accounted for 41 deaths (7% of all deaths), 10 (17%) of the deaths in children aged 1-4 years and 17 (13%) of the deaths in those aged 60 years or more. Immunization against pigbel began in 1980; there were 2 deaths from pigbel in 1-4 year old children in 1980, 1 in 1981, 1 in 1983 and none thereafter.

ALRI accounted for 38% of deaths in children aged less than one year, 27% of deaths in 1-4 year olds and 23% of deaths in adults aged 60 years or more (Table 1). The total number of deaths from ALRI varied by calendar month: when grouped over the 10 years of the study the number of ALRI deaths peaked between May and August (Figure 4). ALRI as a proportion of all deaths varied between 12% in January and 24-25% in May-July, but there was also a peak of 21% in February.

ALRI-specific mortality at varying ages in

children aged less than 5 years in the different geographical areas is shown in Table 2. ALRI mortality was highest in children aged 1-5 months, particularly in the rural areas. During the first year of life mortality from ALRI increased with increasing distance from Goroka town: it was twice as high in Lowa CD (26/1000 pyr) and 2.7 times as high in Asaro CD (34/1000 pyr) as in Goroka town (13/1000 pyr). There were no ALRI deaths in children over the age of 2 years anywhere other than in Asaro CD (Table 2).

Utilization of health services during terminal illness

Place of death

76% (442/582) of all deaths occurred at home and 20% (115/582) in Goroka Base Hospital (GBH). Place of death was similar in males and females but varied markedly with age and place of residence: 40% of 171 deaths under the age of 5 years occurred in a health facility compared to 8% of 298 deaths in people aged 45 years or more ($\chi^2 = 67.3$, $p < 0.0001$). In Asaro CD 81% (303/376) of all

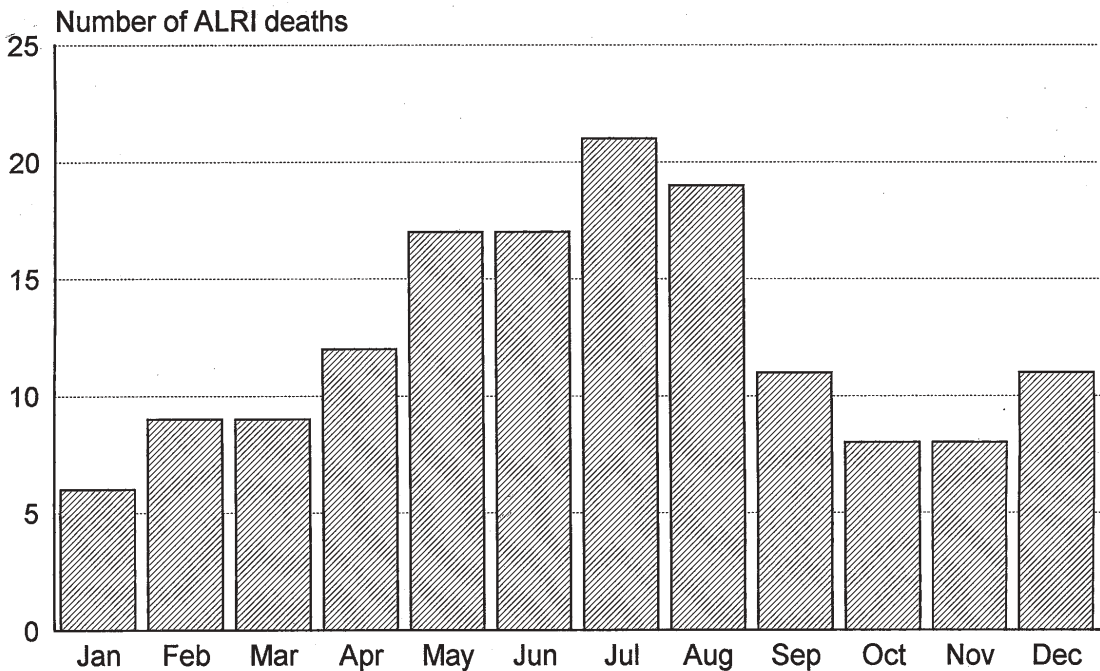


Figure 4. Number of deaths from acute lower respiratory tract infections by calendar month 1980-1989.

TABLE 2

AGE-SPECIFIC ALRI MORTALITY RATES/1000 PYR IN CHILDREN BY PLACE OF RESIDENCE, 1980-1989

Age (months)	Urban Goroka		Periurban		Lowa CD		Asaro CD		Total	
	rate	(n)	rate	(n)	rate	(n)	rate	(n)	rate	(n)
<1	-		-		30.9	(1)	12.6	(1)	12.2	(2)
1-5	24.0	(4)	23.3	(2)	47.5	(7)	58.9	(18)	43.9	(31)
6-11	5.3	(1)	10.8	(1)	5.9	(1)	19.4	(7)	12.3	(10)
12-23	8.3	(3)	6.1	(1)	8.8	(3)	5.6	(4)	6.9	(11)
24-35	-		-		-		4.2	(3)	1.9	(3)
36-59	-		-		-		1.3	(2)	0.6	(2)
Total	4.3	(8)	4.6	(4)	7.4	(12)	9.4	(35)	7.3	(59)

CD = census division

deaths occurred at home compared to 35% (13/37) in Goroka town ($\chi^2 = 36.23$, $p < 0.0001$). In children aged less than one year 68% of deaths occurred at home in Asaro CD compared to 48% in rural and periurban areas of Lowa CD and 31% in Goroka town (χ^2 for trend = 7.95, $p = 0.005$).

Treatment sought during terminal illness

In this analysis the place of treatment refers to the health institution attended during the terminal illness which provided the highest level of health care. 44% of people who died received no treatment at all during their terminal illness (Table 3); however, in the urban area only 11% of those who died had not received any treatment, in part related to the younger age of those living in the urban area. 58% of adults over the age of 44 years and 22% of children under the age of 5 years received no treatment at all during their terminal illness. Distance to a health facility does not seem to be the sole deciding factor for seeking treatment since more than 40% of people who died in the periurban and rural areas of Lowa CD received no treatment during their terminal illness; 50% of those in Asaro CD received no treatment. 74% of urban residents received inpatient care at GBH compared to 44% of those residing in periurban areas, 33% in Lowa CD and 24% in

Asaro CD. Not surprisingly, those resident in rural areas utilized the health centres or aid posts more frequently than those who died in periurban areas and Goroka town: 20%, 13% and 4%, respectively, from Asaro CD, the rural area of Lowa CD and periurban/urban areas had used health centres or aid posts. In children aged less than 5 years, no treatment at a health institution was given to 4% (1/26), 18% (7/39) and 27% (29/106) of those who died in the urban, periurban/rural areas of Lowa CD, and Asaro CD, respectively (χ^2 for trend = 5.47, $p = 0.02$).

We examined further the utilization of health services by people who died of ALRI; they showed similar patterns of health service utilization to that described above for all causes of death. However, children under the age of one year who died of ALRI were more likely to have received some form of treatment than those who died from other causes: only 9% (4/43) of those dying of ALRI had no treatment compared to 33% (23/69) of infants who died from other causes ($\chi^2 = 7.1$, 1 df, $p < 0.01$). This difference was most evident for those resident in the Asaro CD where only 1 (4%) of the 26 children under the age of 1 year who died of ALRI received no medical attention compared to 20 (43%) of 46 infants who died from other causes. It should be noted, however, that 26 of the deaths from non-ALRI

TABLE 3

PLACE OF TREATMENT DURING TERMINAL ILLNESS BY AGE

Age (years)	Nil		Goroka Base Hospital Outpatient		Hospital Inpatient		Health centre		Aid post		Unknown		Total deaths
	n	%	n	%	n	%	n	%	n	%	n	%	n
<1	27	24	5	4	55	49	17	15	8	7	-	-	112
1-4	11	19	8	14	29	49	3	5	7	12	1	2	59
5-9	7	41	3	18	6	35	1	6	-	-	-	-	17
10-14	3	50	-	-	3	50	-	-	-	-	-	-	6
15-29	17	50	-	-	13	38	4	12	-	-	-	-	34
30-44	18	32	5	9	24	43	5	9	3	5	1	2	56
45-59	86	52	12	7	36	22	16	10	11	7	3	2	164
60+	88	66	6	4	14	10	3	2	20	15	3	2	13
Total	257	44	39	7	180	31	49	8	49	8	8	1	582

causes in Asaro CD occurred during the first month of life while all but one ALRI death occurred after the neonatal period. In adults over the age of 44 years people were less likely to seek medical treatment if they died of ALRI: 76% (41/54) of those who died of ALRI had received no treatment compared to 55% (133/244) for those who died from other causes ($\chi^2 = 7.49$, 1 df, $p < 0.01$).

People died of ALRI at home despite having been treated as inpatients at GBH: of the 97 people who died of ALRI at home, 14% had been inpatients at GBH during their terminal illness, 8% had been outpatients at GBH, 8% had received treatment at a health centre and 15% were treated at an aid post. Of the 36 people who died of ALRI and had received inpatient treatment at GBH, 14 (39%) subsequently died at home; in children under 1 year of age the equivalent figure was 48% of 21 ALRI deaths.

Discussion

It is not easy to monitor demographic events in any society, even less so in countries where registration of births and deaths is not compulsory and migration rates are high. Demographic surveillance has taken place over varying lengths of time in several areas of PNG (and is ongoing in the Wosera region of East Sepik Province) as part of epidemiological

studies of pneumonia, diarrhoea and malaria (2, 6-9). These studies provide population-based estimates of mortality. Methods of demographic surveillance and determination of cause of death were developed in Tari, Southern Highlands Province from 1971 onwards (6,7) and have been refined both there and in the Asaro Valley during the study reported here. When many deaths occur outside health facilities, verbal autopsies can provide useful information on the causes of death and thus assist in identifying what interventions are necessary to reduce mortality. Nevertheless, verbal autopsies have their limitations; rare diseases may not be detected by this method and in some cases the diagnosis will be imprecise. For example, it is unknown how many people who died of chronic abdominal disease actually died of hepatoma, which is known to be common in the highlands of PNG. Furthermore it is not easy to distinguish between malaria and ALRI as a cause of death in malarious areas.

We found marked differentials in mortality even within a short distance of an urban centre. All parameters of mortality were higher in Asaro CD than elsewhere in the area under surveillance despite the fact that people in this area live within 1-1/2 hours' drive of Goroka town and that a health centre at Asaro station is located on the Highlands Highway in this census division. All villages under

surveillance in Asaro CD are within $\frac{1}{2}$ -1 hour's drive of the health centre and are generally accessible by an all-weather road throughout the year. Nevertheless utilization of health services among those who died in Asaro CD was lower than elsewhere.

Preliminary analysis of some socioeconomic and anthropometric data help shed some light on why there may be such high levels of mortality in Asaro CD. As part of a socioeconomic survey of the monitored population, interviews with heads of households showed in 1984-1985 that 20% of 754 interviewees in Asaro CD had received some schooling compared to 35% of 339 in Lowa CD, 50% of 214 in the periurban area and 83% of 292 in Goroka town (N. Yupa, D. Lehmann et al., unpublished observations). Inevitably the town population will have had more schooling since it is a younger population than the other areas and the more educated are also more likely to be able to obtain employment in town, but the differences between the other areas are also pronounced. There was not a marked difference in reported income; however, as an indication of available cash, 16%, 23%, 30% and 58% of those living in Asaro CD, Lowa CD, periurban and urban areas, respectively, owned a radio. Between 1981 and 1985 nutritional status, measured during a trial of pneumococcal polysaccharide vaccine (10), showed that the prevalence of stunting in children aged 6-59 months increased with increasing distance from Goroka town: for example, in the 12-17 month age group mean height for age z-scores were -1.11, -1.31, -1.66, -1.98 in Goroka town, periurban areas, rural Lowa CD and Asaro CD, respectively (H. Gratten, D. Smith, I.D. Riley et al., unpublished observations). Equivalent figures in the 36-47 month age group were -1.20, -0.82, -1.72, -2.54, respectively.

Comparison of mortality between different areas of PNG

Mortality in the Asaro Valley is similar to the national average from the 1980 census (11). Mortality rates from three sites where very similar methods of demographic surveillance were used and also nationwide rates from rural areas are shown in Table 4. The area under surveillance in Madang was a rural lowland

area near Madang town while demographic surveillance in Tari was in a rural area 4 hours' drive from the provincial capital, with one part of the Tari Basin being at lower altitude where the prevalence of malaria is high. Contact with western culture occurred 20 years later in Tari than in the Asaro Valley. Mortality was lower in Madang than in the other two sites though neonatal mortality was high at all sites. While mortality was generally higher in Tari than in the Asaro Valley, the rates were very similar in the more remote Asaro CD to those found in Tari. Neonatal mortality in Asaro CD was particularly high, the same as in the more malarious region of Tari (7). ALRI accounted for the same proportion of deaths in Tari as in the Asaro Valley but the ALRI-specific mortality rate was higher in children in Tari and lower in Madang than in the Asaro Valley. However, apparent differences in mortality from ALRI or febrile illnesses between highland and coastal regions should be viewed with caution in view of the difficulty of distinguishing between ALRI and malaria by verbal autopsy. Other notable differences to be considered when comparing ALRI mortality in highland and lowland populations include housing, location of kitchen in relation to sleeping place, in-house ventilation, the number of residents per household and child-caring practices.

The maternal mortality rate of 3/1000 births in the Asaro Valley may be an underestimate since local taboos make it difficult to discuss events related to pregnancy and childbirth; nevertheless it is high and of the same order as found in Tari (7) and Madang (8), but lower than the estimated rural maternal mortality for the country as a whole at the time of this study (12). A high proportion of infant deaths occurred during the neonatal period both in Madang and in the highland areas of Tari and the Asaro Valley (Table 4). Data collected between 1986 and 1989 show that the number of supervised deliveries in the Asaro Valley declines with increasing distance from Goroka town, ranging from 95% in the urban area to 64% in rural areas of Lowa CD and 55% in the Asaro CD (K. Coakley, C. Coakley, D. Lehmann, D. Russell et al., unpublished observations). These findings all point to the need for ensuring healthy pregnancy, supervision of deliveries and provision of

TABLE 4

COMPARISON OF MORTALITY RATES IN THE ASARO VALLEY AND ASARO CENSUS DIVISION (1980-1989), TARI, SOUTHERN HIGHLANDS PROVINCE (1982-1990), MADANG (1982-1983) AND RURAL AREAS OF PNG (1980)

Mortality rate	Asaro Valley	Asaro CD	Tari ^a	Madang ^b	PNG rural ^c
Crude death rate/1000/annum	9.7	12.3	12.3	8.7	14.2
Infant mortality/1000 livebirths	59.9	84.2	85.3	45.9	79.0
Neonatal mortality/1000 livebirths	21.4	32.7	24.4	22.0	24.5
1-4 mortality/1000/annum	9.2	11.1	10.4	6.9	12.7
<1 year ALRI/1000/annum	24.7	34.9	44.6	14.3 ^d	NA
1-4 year ALRI/1000/annum	2.5	3.0	3.0	1.5 ^d	NA
Maternal mortality/1000 births	3.1	3.4	2.1	4.1	8.0 ^e

^a Reference 7

^b Reference 8

^c Reference 11

^d Estimated from proportion of deaths caused by pneumonia and mortality rates for relevant age group

^e Reference 12

CD = census division

NA = not available

facilities for care of the neonate. User fees have been introduced at GBH for individual services including obstetric delivery, postnatal care, provision of a health record book, prescription of drugs, laboratory investigations, X-ray examinations and the use of the hospital mortuary. Evidence from other parts of the world indicates that user fees are difficult to manage, often account for only a small proportion of costs, result in reduction of utilization of health services, increase inequity and in some places have resulted in an increase in maternal mortality and the incidence of infectious diseases (13). In order to promote delivery under medical supervision in PNG user fees should at least be waived for pregnant women.

Cause-specific mortality

Acute lower respiratory infections continue to be the commonest cause of death in PNG. In order to reduce mortality from ALRI case management must be improved and antibiotics have to be available as near people's homes as possible. In the highlands of PNG pneumococcal polysaccharide vaccine has been

shown to prevent deaths from ALRI in children aged 1-4 years (10) when given to children aged 6 months or more. The potential impact of this vaccine in the Asaro Valley may not be high since ALRI-specific mortality is low after the first year of life and 73% of ALRI deaths in children under the age of 5 years occur during the first year of life. Conjugate pneumococcal vaccines, which are more immunogenic in young children, are being evaluated elsewhere and may assist in reducing mortality in children. *Haemophilus influenzae* type b (Hib) is another important cause of pneumonia in children in PNG (14) and multiresistant strains have now been isolated (15). Conjugate Hib vaccine has been shown to prevent severe pneumonia in The Gambia (16) and is immunogenic in Papua New Guinean children (17). Inclusion of conjugate Hib vaccine in routine immunization programs is planned in PNG. However, immunization coverage at present is poor (18) and a Hib vaccine program is unlikely to have much impact until coverage improves through regular mobile maternal and child health (MCH) services in rural areas. The urgency of improving immunization coverage is also highlighted by the emergence

of measles as a major problem, in particular the very high incidence of subacute sclerosing panencephalitis (19), which is a serious and invariably fatal complication of the disease.

Typhoid was relatively rare at the time of this study, but is now endemic in the Asaro Valley (20). On the other hand enteritis necroticans (pigbel), which was once a very common childhood condition, has virtually disappeared (21).

Trauma was the most common cause of death in young adults and homicide was common. With increasing interclan warfare, breakdown in law and order and widespread use of firearms the homicide rate is likely to have risen during the past decade. The reason for the high homicide rate in elderly females is due to their being suspected of causing another's death through sorcery.

Health service utilization

Urban residents and young children in the Asaro Valley used the health services most and utilization declined with increasing distance from Goroka town. Older people are less likely to use health services since both they and their relatives accept that they may soon die and that medical treatment is unlikely to help them. We found that even when people received inpatient care, many subsequently died at home. Data from GBH indicate that 16% of children abscond. In some instances doctors discharge patients prematurely, but if a patient is seriously ill and likely to die, relatives often choose to take the patient home, perhaps to try traditional forms of medicine as a last resort, to avoid the expenses involved in transporting a dead body home and to allow the patient a more dignified death.

Recommendations

In order to reduce mortality in rural areas, first and foremost there must be a political commitment to the provision of functioning health services and education facilities in rural areas. Since this study took place many aid posts have closed and, apart from clinics run by staff at church health subcentres, mobile MCH clinics have virtually ceased. More supervision and greater staff commitment are

required to ensure that adequate services are provided in rural areas. To provide health services in rural areas it will also be necessary to tackle law and order problems since health workers will not live or travel to areas where they feel their own or their family's lives are at risk. Health education should include signs and symptoms of severe disease requiring medical attention, the importance of seeking medical attention early during an illness, the need for adequate nutrition during and following illness and the importance of compliance with treatment regimens. User fees should be waived for pregnant women. MCH clinics must be carried out regularly in rural areas to ensure adequate immunization of children and antenatal care for mothers.

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