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Demography and causes of death among the Huli in the Tari Basin

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SUMMARY

Monthly demographic surveillance by local reporters was continuous in the Tari Basin from 1971 until 1995 and cause of death was determined primarily by verbal autopsy. In 1982 the de jure population was 26,500, 15% aged less than 5 years. Crude birth rate was 34/1000/annum in 1980-1984; from 1977 to 1983 crude mortality rate was 15/1000/annum and life expectancy at birth 50 years. Infant mortality fell from 160 in the 1920s to 72/1000 livebirths in the 1970s, the greatest decline occurring between 1952 and 1971 when antibiotics became widely available. Respiratory disease (particularly chronic lung disease in adults) accounted for 39% of all deaths, and pneumonia for 50% and 33% of infant and toddler deaths respectively. Very few deaths from pigbel have occurred since the introduction of pigbel vaccine. Initially childhood mortality from diarrhoea declined following introduction of an oral rehydration program but subsequently rose when medical attention was no longer sought and children were inadequately treated at home. The higher mortality in the lower-lying Iumu area was attributed to malaria. Since the opening of the Highlands Highway in 1981, there has been a dramatic increase in short-term movement of both men and women in and out of Tari resulting in increased incidence of sexually transmitted diseases and viral infections such as measles. If restored, the Tari Research Unit could continue to play a key role in assisting the Department of Health in making decisions on appropriate interventions to improve the quality of life of Papua New Guineans.

Introduction

In this paper I describe the demography of the Tari Basin, in particular the changes in the number of births and deaths over time and the changes in migration patterns, and I discuss the main causes of death. All this information is very important to the task of finding ways to reduce mortality and also for recording changes in the mobility of the population, which has almost certainly resulted in the introduction of new diseases, given that people lived in relative isolation until fairly recently. It is important to monitor the number of births occurring in Tari since rapid population growth may result in increased pressure on land. Conversely, a reduction in fertility may be caused by the introduction of sexually transmitted diseases.

Demography: Methods

Demographic surveillance was established by Ian Riley in fifteen census units (population approximately 11,000) in the East and Central Basin Census Divisions in 1971; by 1973 the surveillance area had been expanded to include a further twenty-two census units in the North Basin, Puijero, Haibuga-Munima and Iumu Census Divisions. In the late 1970s one census unit was divided into two, making no difference to the size of the surveillance population. In mid-1982 four census units (Kela, Pai Habalu, Tibiribi and Hare) were removed from the surveillance area, reducing the total number of census units under surveillance to 34. In 1982, the Tari Research Unit (TRU) was employing 26 reporters, overseen by 3 reporter supervisors, to monitor

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more than 26,000 people. The TRU became a branch of the Papua New Guinea Institute of Medical Research in 1985. For logistic and financial reasons demographic surveillance ceased in 1995, and the Unit closed in 2000.

The population under surveillance included all people claiming affiliation to clans in the area under surveillance, irrespective of whether they were permanently resident in the area or not. Reporters were males affiliated to the clans they monitored and had at least primary school education. During the period covered by this report, female reporters were not employed since Huli women had difficulty obtaining information from males and their mobility was restricted for social reasons. This was not ideal since males (particularly young and unmarried ones) are at a disadvantage when collecting fertility information.

Each reporter monitored between 600 and 1000 people who were listed in family groups in books held by each reporter. A reporter generally covered one or more census units consisting of a number of clans whose members occupy an area of land obtained through inheritance. Reporters were required to visit each person recorded in their books once every four weeks and record whether a person was present or not and any demographic event, eg new entrant into the study area, marriage, birth, death, divorce, migration. Each demographic event was dated as accurately as possible. Migrations were recorded after a person had been absent (or returned) for 2 consecutive months.

Since many Hulis are not necessarily resident on their own clan ground, fortnightly meetings of all reporters were important to exchange information about events occurring outside the areas of individual reporters. All data were collated by office staff on a monthly basis, recorded on individual persons' cards kept in the Tari office and also entered on computer files in Mendi.

In the 1970s and early 1980s censuses were undertaken by the TRU in each census unit at intervals of one or two years as an independent check on the quality of data collected by reporters. Since people live in scattered homesteads, it was necessary for them to congregate at a central point. Under the Australian administration, attendance at a census was compulsory, but as time has gone on, attendance rates have dropped so markedly that there is now little point in doing censuses, especially since those people who pose problems with respect to identity and status tend not to be present at censuses. Censuses carried out in 1979 and 1980 were nevertheless useful in resolving demographic problems and collecting new information which had been missed between 1977 and 1979 as a result of poor surveillance.

Demography: Results

Age and sex distribution

In mid-1982 the TRU had 26,490 people under demographic surveillance. The age distribution of this population (Figure 1) was broad-based with 15% under 5 years of age and 38% under 15 years. 13% of the mid-year population were absent from the area under demographic surveillance, with a much higher proportion of young adult males than young adult females absent (1). There was an equal number of males and females in the total de jure population in mid-1982, though the male:female ratio at birth was 104:100.

Fertility

Between 1980 and 1984 the crude birth rate of this population was 34/1000/annum, the total fertility rate 4.7, the mean age of fertility 31.4 years and the net reproduction rate (ie, the expected number of surviving female births per woman) 1.9. The fertility rate had increased slightly from that found in 1972-1974 (2). A net reproduction rate of 1.9 indicates that the female population is likely to almost double within a generation at current levels of mortality.

Between 1981 and 1984 the mean birth interval between a livebirth and a subsequent birth was 36 months, suggesting that customs which prohibit intercourse during the postpartum period and while women are lactating (3) were being followed. However, the birth interval lengthened with increasing age of women (34.1, 37.2 and 40.0 months among women aged 20 to 24, 30 to 34 and 40

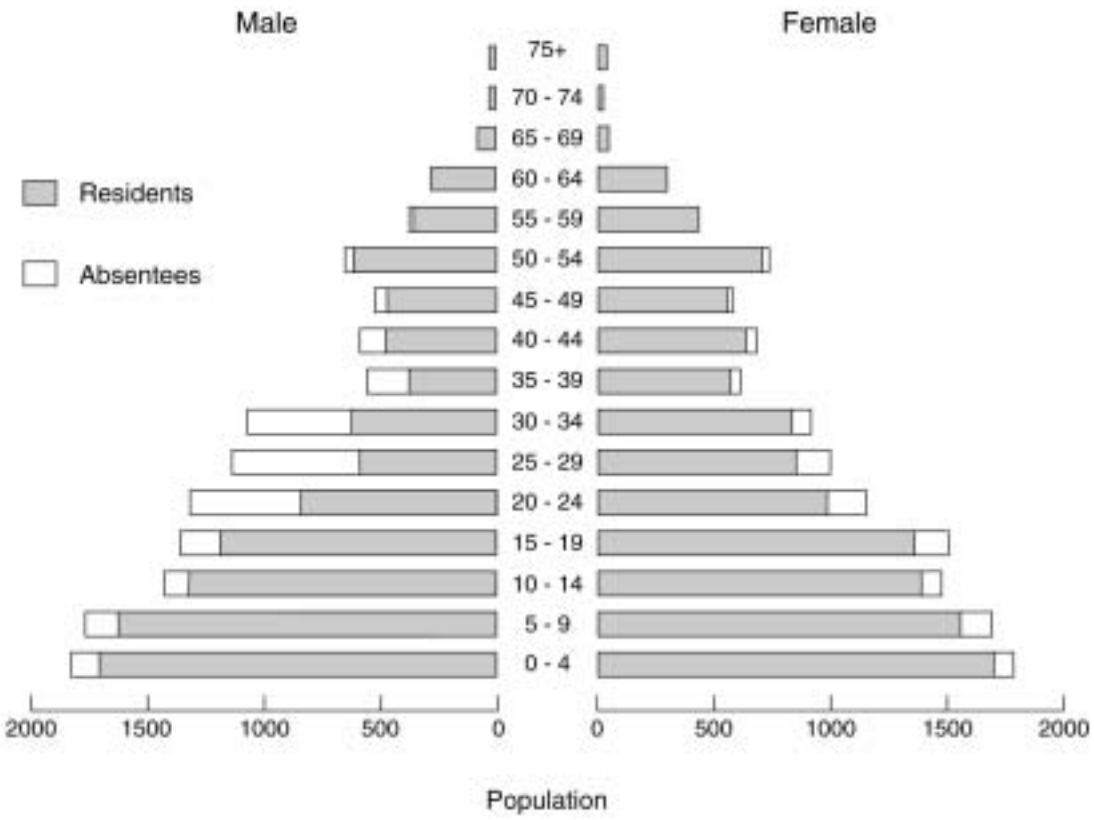

Figure 1. Population pyramid of the population under demographic surveillance in Tari on 30 June 1982 showing the age and sex of residents and absentees. Source: Lehmann (1).

to 44 years, respectively); this may reflect declining fertility with age but may also indicate that an increasing number of younger couples are not observing customary restrictions on intercourse. In contrast to the prolonged interval between a livebirth and a subsequent birth, the interval between a stillbirth and a subsequent birth was only 22 months. Women whose children die in the first year of life also become pregnant again sooner than the mean birth interval for livebirths. Interventions are required to improve the quality of antenatal and postnatal care (as well as the utilization of services which are currently available) to avoid both the emotional upset of losing a child and the stress on women of frequent pregnancies in close succession.

Mortality

Between 1977 and 1983 the crude death rate in the area under demographic surveillance in Tari was 15/1000/annum and life expectancy at birth was 50 years. Figure 2 shows the probability of dying ($_nq_x$) for males and females by age between 1978 and 1982 (1). Mortality was moderately high in young children, lowest between the ages of 10 and 20 years and thereafter rose steeply. Pneumonia in young adults as well as the early onset of chronic lung disease account for the sharp rise in mortality in early adulthood.

Age-standardized mortality rates were determined to allow for differences in age structure of populations in the different census divisions. The standardized mortality rate was higher in Iumu Census Division than elsewhere (20/1000/annum). It is likely that malaria contributes to the higher mortality in this division, which is lower in altitude than other parts of the surveillance area. To improve health services in Iumu Census Division, the Division of Health of the Department of Southern Highlands Province built a small health centre in Idauwi in 1987.

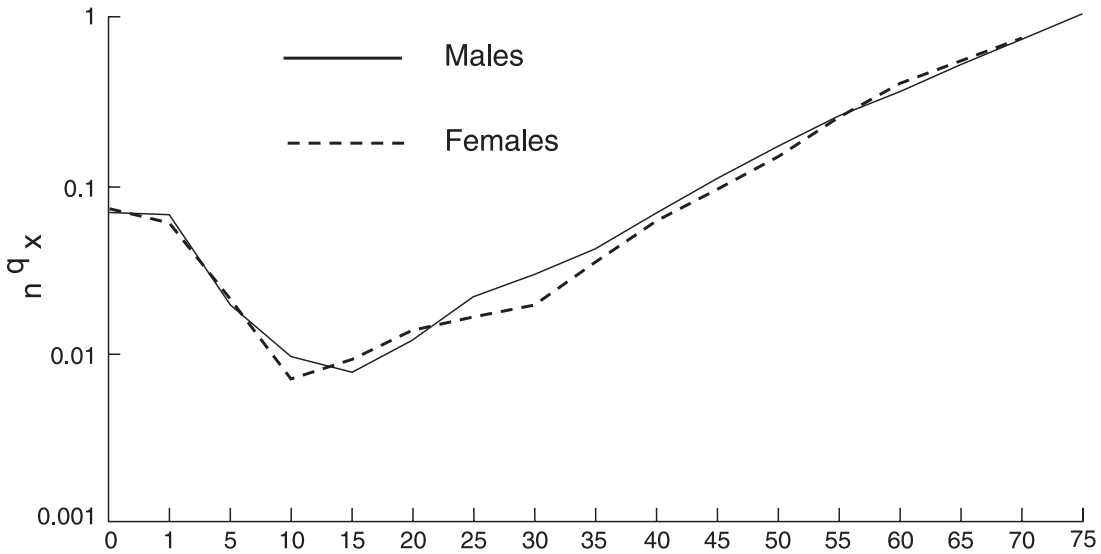

Figure 2. Probability of dying ($_nq_x$) by age and sex between 1978 and 1982 in Tari. Source: Lehmann (1).

Infant mortality

Riley obtained retrospective fertility histories from a random sample of 774 women, enquired about the outcome of their pregnancies and the survival of their offspring, and estimated the age at death for any of their children who had died (2). The reconstruction of estimated infant mortality rates from these data indicates that a dramatic decline occurred in infant mortality from an estimated 160/1000 livebirths in the 1920s to 72/1000 in the early 1970s (Table 1).

The most rapid decline in infant mortality occurred between 1952 and 1971. During this period the colonial administration lifted restrictions on the establishment of mission and government posts outside of the immediate area of Tari airstrip and basic health care could be extended to the larger Huli population. Primary health care workers with minimal training were able to have a marked impact on infant mortality in the absence of any accompanying social or economic services or infrastructural development because pneumonia accounted for at least half of all

TABLE 1

COMPARISON OF PERINATAL AND INFANT MORTALITY RATES (PER 1000 LIVEBIRTHS) AS DETERMINED BY RETROSPECTIVE QUESTIONING OF MOTHERS BEFORE 1972 AND BY DIRECT ENUMERATION FROM 1972 TO 1983

	Retrospective questioning			Enumeration	
	1920-1951	**1952-1964**	**1965-1971**	**1972-1974**	**1980-1983**
Stillbirth*	41.3	39.0	29.7	?	16.3
Neonatal mortality	48.2	30.6	30.6	26.6	19.4
Postneonatal mortality	111.9	89.6	37.6	45.8	54.8
Infant mortality	160.1	120.1	68.2	72.3	74.2

*rate/1000 total births
Sources: Riley (2), Lehmann (1)

infant deaths, and it could be treated with penicillin. Infant mortality did not decline further during the 1970s and 1980s and the postneonatal mortality rate actually increased. This pattern suggests that once mortality has fallen from a very high level to an intermediate level in rural areas it may be difficult to reduce mortality further without providing interventions additional to basic health services.

The improved enumeration of infant deaths may have caused a slight increase in mortality rates, but the emergence of strains of *Streptococcus pneumoniae* resistant to penicillin, the increased mobility of the population and the resultant increase in transmission of viral infections (eg measles) as well as a decline in the quality of health services are more probable reasons for the lack of further decline in infant mortality.

Migration

During the 1960s and 1970s, young Huli men were recruited to work on plantations elsewhere in Papua New Guinea (PNG) through the Highlands Labour Scheme (4, 5). However, many men soon became disillusioned with the poor conditions and remuneration and either returned to Tari or left the plantations to seek work on nearby government stations and in towns. In more recent years, particularly since the completion of the Highlands Highway in 1981, Huli men and women have travelled extensively to other parts of the highlands as well as to Lae and Madang in search of employment, to experience town life, and to sell pigs and vegetables. During the 1980s more than 40% of men aged 20-39 years were absent from Tari at any particular time. While men and women aged 20 to 30 years were the most mobile, travel was by no means restricted to that age group (Figure 3).

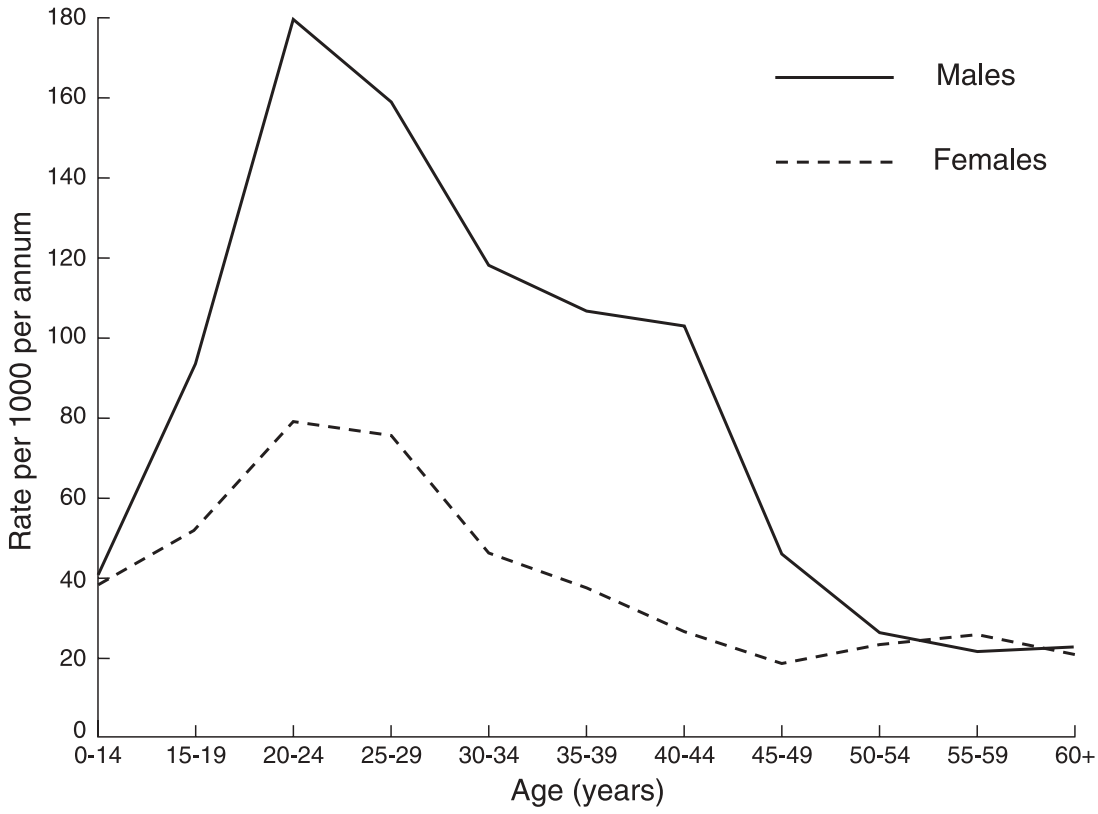

Figure 3. Migration rate out of Tari by age and sex between 1980 and 1984 (migrations/mid-year de jure population/1000/annum).

Patterns of migration have changed over time. In 1973, 44% of men aged 15-29 years were absent from the East and Central Census Divisions of Tari for a period of six months or more (2) compared to only 23% in 1983, which suggests a decline in the number of people moving away from Tari for prolonged periods. The decline in the male:female ratio of the 15-29 year age group away from Tari for a period of six months or more from 5.8:1 in 1973 to 2.6:1 in 1983 reflects the increasing numbers of young women who began living away from Tari during that period.

The construction of the road which linked Tari to other parts of the highlands resulted in a dramatic increase in the number of short-duration absences by men and women from Tari (Figure 4). Between 1980 and 1984, the total number of migrations rose three-fold but in view of the shorter time spent out of Tari, the number of people absent from Tari at any particular time changed little over the same period. The figures presented here are underestimates of the frequency of migration out of Tari because absences of less than two months are not recorded. Figure 5 shows where young men and women went (or at least where they were intending to go) between 1980 and 1984. The most common stated destinations for short-duration migrants were those areas near Tari occupied by Huli speakers, such as Koroba and Margarima, or areas with which the Huli have historical and cultural affiliations, such as the upper Wage Valley in southern Enga and Porgera. The Porgera goldmine now provides an additional attraction. On the other hand previously popular destinations may suddenly cease to be attractive. Many Huli fled Mount Hagen in 1981 after fighting broke out between Enga, Huli and locals; despite good road access, the Huli were reluctant to travel to Mount Hagen over the next year or two.

A large number of Huli have thus been exposed recently and rapidly to the outside world and to non-Huli societies, including the extensively westernized towns. Prior to 'pacification', Huli men had a tradition of travelling and trading beyond the confines of their own cultural territory. Modern movements are an extension of this tradition and many Huli are keen to experience the attractions of the world beyond the Tari Gap. The benefits of frequent travel in and out of Tari include the potential of participating in a cash economy, the import of goods to Tari and experience of the new world. However, on the negative side, movement of Huli, other Papua New Guineans and foreigners in and out of Tari has resulted not only in a dramatic increase in the incidence of sexually transmitted diseases but also in the import of

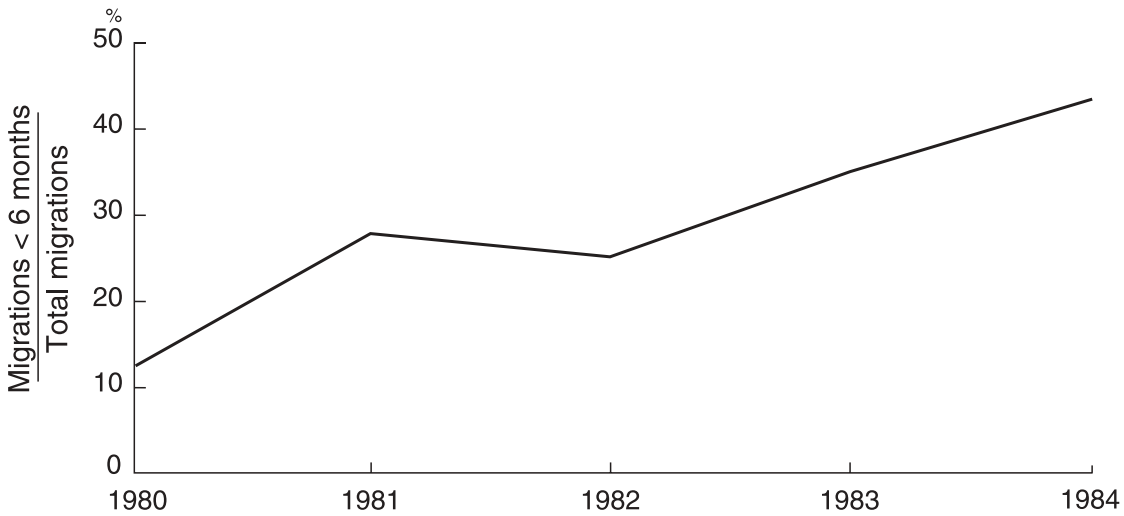

Figure 4. Proportion of all migrations which were less than 6 months' duration among adults aged 15-39 years (1980 to 1984).

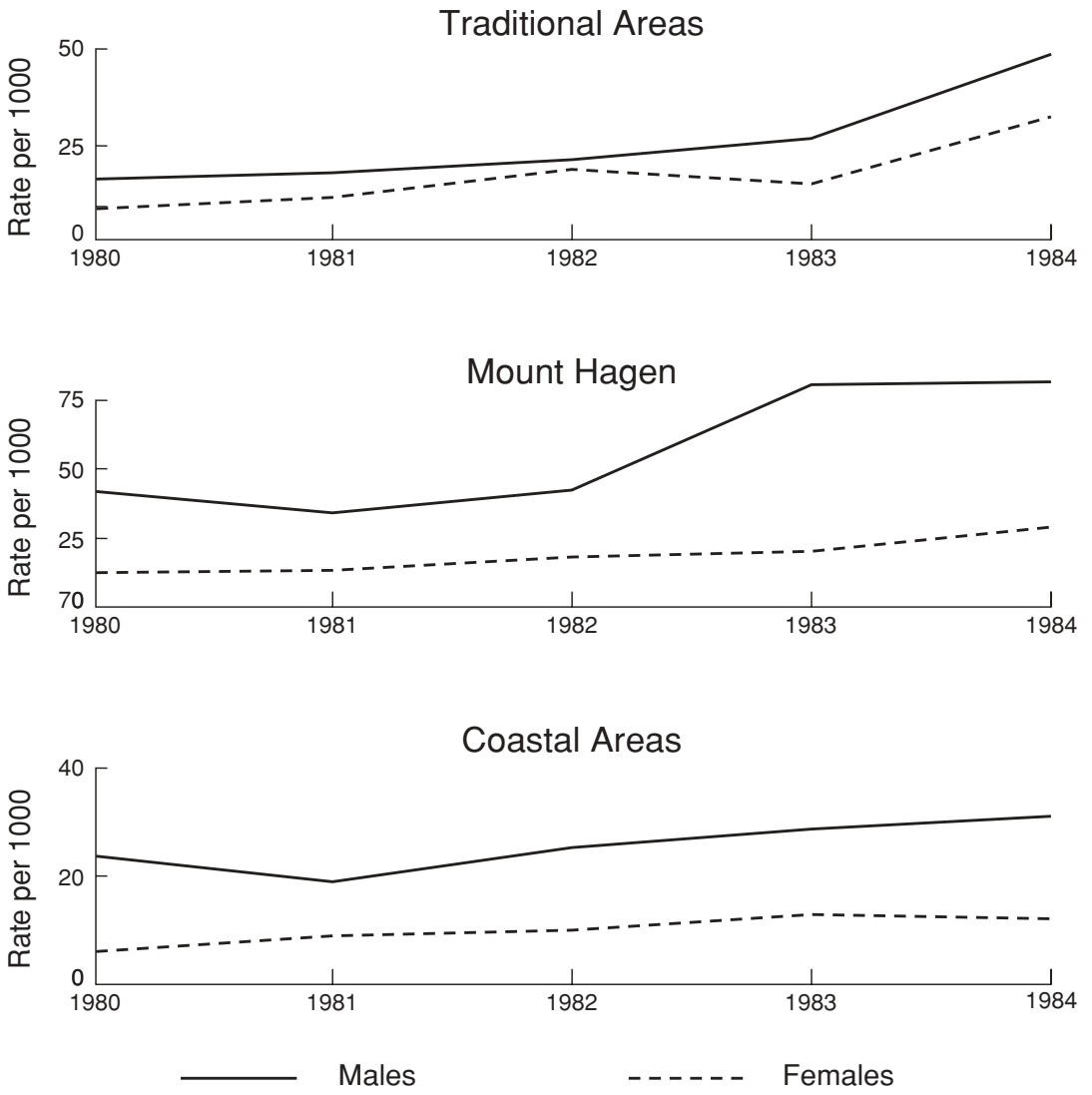

Figure 5. Migration rate (/1000/annum) of males and females aged 15-44 years between 1980 and 1984 to (a) nearby areas with which the Huli have historical links, (b) Mount Hagen and (c) coastal areas.

viruses such as measles and influenza to which people might not otherwise have been exposed. Previously, the bachelor cult which stressed the dangers of premature sexual relations with women, and its 'replacement' – labour migration for up to three years – meant that men did not marry until they were around 10 years older than women. The present short-term migration pattern of both men and women, as well as the tendency for men to take their wives with them out of Tari for longer periods of time, gives rise to a tendency to marry earlier and for men to become fathers at a younger age.

Population growth rates in Tari

Between 1977 and 1985 the annual population growth rate of the de jure population was 2.2% in the area under demographic surveillance. Given this growth rate, assuming no sudden changes in fertility, mortality and migration, the population will double within 32 years. There were 25,700 people under regular demographic surveillance in 1980; at this growth rate, it is estimated that there would have been more than 38,000 people living in the same area in the year 2000. During the 1970s and early 1980s, there was

little change in mortality and fertility rates. However, the 1980s saw major social changes in Tari as a result of the Highlands Highway providing road links to other parts of PNG, availability of cash from the Porgera and Mt Kare gold mines situated to the north of Tari and employment possibilities at both Porgera and Ok Tedi mines. A more likely scenario in the years to come is that of declining mortality (as a result of increased utilization of health services and the availability of new vaccines to prevent childhood deaths) and increasing fertility (as a result of shorter birth intervals), which would result in more people residing in the Tari Basin than the existing demographic projections predict. The central part of the Basin is already one of the most densely populated areas in PNG (165 persons/km^2 in the 1980s). It is now urgently necessary to address the question of how to deal with the rapid changes taking place in Tari by considering measures discussed elsewhere in this issue by Wood (6) to improve soil fertility and increase crop yields. Access to education must be ensured and participation in the cash economy encouraged. The provision of adequate family planning services is already an expressed felt need of women in Tari (7) but one which is not always shared by Huli men.

Causes of Death: Methods

Only 20% of all deaths in the population under surveillance in Tari occur in hospitals and health centres (1). Riley developed a 'verbal autopsy' questionnaire in the early 1970s to determine the cause of death of persons dying outside health facilities, and the same method has been used continuously to the present day with only minor amendments (1, 2). When a TRU reporter informs office staff of a death in the population under demographic surveillance, a Huli mortality clerk (who is not medically qualified but is specifically trained to collect verbal autopsies) visits relatives of the deceased as soon as appropriately possible and collects information on the symptoms which occurred during the terminal illness. The sequence of events is recorded on the reverse of the form and the relatives are asked whether the deceased received any medical treatment during the terminal illness. Any additional information available from health workers is also collected. The epidemiologist in charge of TRU then codes the cause of death according to the 'Classification of Symptom Complexes for Lay Reporters' developed by Riley for use in population-based studies in PNG. The classification is based on the 9th Revision of the International Classification of Diseases (8).

Causes of Death: Results

Respiratory disease accounted for 39% of all deaths in Tari between 1977 and 1983 (Table 2) (1). More than half of the deaths in children under one year of age and one-third of deaths in the 1-4 year age group were due to acute lower respiratory tract infections (ALRI). Chronic lung disease, a disease well-known to the Huli as *amali*, accounted for 24% of all deaths over the age of 44 years and ALRI (which in some cases may in fact have been the terminal event of chronic lung disease) for a further 19% of deaths in the same age group. The cause of death was unknown for many deaths among the elderly since the death of the aged is accepted as normal and relatives merely say that the person has died of old age.

Though 7% of all deaths were due to gastroenteritis or dysentery, these diseases accounted for 22% of deaths in children aged 1 to 4 years. Measles was the underlying cause of death in 4% of children under 5 years of age. Intentional and unintentional injuries (eg, homicide, road traffic accidents, drowning, burns and, in the case of young adult females, suicide) accounted for 20% of all deaths in the 15-44 year age group and was the commonest cause of death in this age group.

Changes in cause-specific mortality 1972-1983 and the impact of some intervention programs

Acute lower respiratory tract infections

In children under 5 years and adults aged 45 years or more, ALRI mortality rates increased between 1972-1974 and 1977-1983 (1, 2). The widespread use of penicillin which may have been responsible for the emergence of resistant strains of *Streptococcus pneumoniae*, the introduction of new viruses to a previously unexposed population or a decline in the quality of curative services in Tari are possible

TABLE 2

CAUSE- AND AGE-SPECIFIC DEATH RATES IN TARI 1977-1983 (RATE/1000/ANNUM)

Age (years) **Person-years at risk**	**<1** **3468**	**1-4** **16162**	**5-14** **43553**	**15-29** **41121**	**30-44** **25241**	**45-59** **23762**	**60+** **5574**	**Total** **158881**	**%**
ALRI	35.9	6.0	0.5	0.2	1.1	6.1	19.5	3.4	23.0
Chronic lung disease	0.3	-	-	-	1.0	7.5	25.6	2.3	15.5
Gastroenteritis	3.1	2.6	0.2	-	0.2	0.9	2.5	0.6	4.1
Dysentery	0.6	1.3	0.3	-	0.1	1.3	2.2	0.5	3.4
Pigbel	0.3	1.5	0.2	-	-	0.1	0.2	0.3	2.0
Other abdominal disease	1.1	1.1	0.1	0.3	1.0	2.5	6.6	1.1	7.4
Measles	2.6	0.9	-	-	0.1	0.2	1.4	0.3	2.0
Other febrile illness	5.4	1.0	0.4	0.3	0.8	3.0	6.0	1.2	8.1
Trauma	0.9	1.1	0.3	0.9	1.1	1.2	1.4	0.9	6.1
Maternal deaths	-	-	-	0.1	0.4	0.1	-	0.1	0.7
Unspecified neonatal/ congenital abnormalities	14.0	0.2	-	-	-	-	0.5	0.3	2.0
Other	2.3	0.8	0.2	0.6	0.4	1.1	2.1	0.5	3.4
Unknown	1.4	1.4	0.2	0.6	1.8	7.7	41.8	3.3	22.3
Total	67.9	17.9	2.4	3.0	8.0	31.7	109.8	14.8	100.0

ALRI = acute lower respiratory tract infections

causes for this trend. In contrast, during the period when pneumococcal polysaccharide vaccine was being evaluated in children aged 4 months to 5 years (9, 10) ALRI mortality fell significantly among children aged 1-4 years even though only half the trial participants received vaccine while the other half received placebo: in this age group ALRI mortality was 2.9/1000/annum in 1981-1983 compared to 6.9/1000/annum in the 1977-1979 period. In the intervening year, 1980, there was an influenza epidemic which caused very high ALRI mortality in all age groups. In addition to a 58% reduction in ALRI mortality among children who received pneumococcal vaccine in the Tari trial, since ALRI accounts for such a large proportion of all deaths, mortality from all causes was 30% lower in the vaccine than in the placebo group (9).

Pigbel

Pigbel, otherwise known as enteritis necroticans, was previously the commonest cause of death in children aged 5 to 14 years and a frequent cause of death in younger children as well. Following a successful trial of pigbel vaccine in children in Simbu Province in the 1970s (11), three doses of pigbel vaccine were offered to all children attending maternal and child health clinics in the highlands region and to schoolchildren who had not been previously vaccinated. The immunization program began in Tari in 1981. The number of deaths from pigbel among children under 5 years of age fell from 36 (mortality rate 0.4/1000/annum) between 1977 and 1980 to 5 (mortality rate 0.07/1000/annum) between 1981 and 1983 (1), providing strong evidence that the immunization program had been successful.

Diarrhoea

In 1980, an oral rehydration program aimed at reducing the number of deaths from dehydration associated with diarrhoea was started in the Southern Highlands Province. Health workers were trained and provided with packets of oral rehydration salts and a jug to prepare a solution to give people suffering from diarrhoea. Posters were prepared to promote oral rehydration. The diarrhoea-specific mortality rate in children aged less than 5 years declined from 3.3/1000/annum during the 1977-1980 period to 1.1/1000/annum between 1981 and 1983 (12). Although the program was successful, a follow-up investigation found that the purpose of the rehydration was not clear to many parents. People followed recommendations made by health workers, but they did so without conviction and remained sceptical of the effectiveness of giving more fluids to children excreting watery stools (12). It was concluded that unless the rationale behind oral rehydration therapy was explained in the context of Huli concepts of physiology, the program would fail. Sadly, this proved to be the case: diarrhoea-specific mortality rose and mothers stopped seeking medical advice for their children suffering from diarrhoea, partly because health workers were telling mothers to 'give fluids at home' rather than bring children to the aid post or health centre (13).

Measles

For a long time measles was not considered a major health problem in most of the highlands region. Between 1971 and 1976, there were only 5 deaths from measles in Tari (mortality rate 0.04/1000/annum) while there were 48 deaths between 1977 and 1983, most of these occurring after 1980 (mortality rate 0.3/1000/annum). Increased mobility of the population has resulted in increased exposure to the measles virus. A study in Goroka has shown extremely high case fatality rates in the urban setting and particularly in children under the age of one year (14). Furthermore, unusually high rates of subacute sclerosing panencephalitis (SSPE), a rare but invariably fatal complication of measles, have been reported in PNG (15). Studies in Tari have shown that many children can mount a good antibody response to measles vaccine as early as 5 months of age (16). In 1990, the PNG Department of Health approved nation-wide measles immunization at 6 months of age, and every effort should be made to immunize children at this age, together with a later booster.

New intervention and disease control programs

The data collected by TRU staff on causes of death have indicated priority areas for

interventions aimed at reducing mortality and the data have been used to evaluate intervention programs as well as new methods of disease control. In order to obtain reliable cause-specific mortality rates, it is essential to have an accurate denominator, ie, a correct count of people among whom cause of death is being ascertained. The demographic data collected by TRU staff provided this information, but the collection and collation of the demographic data were the most time-consuming and expensive parts of the Unit's activities. Population-based data in Tari have assisted in evaluating health intervention programs for more than 20 years and in addition have provided the base for studies of land use, agronomy and nutrition described elsewhere in this issue. The TRU became a branch of the Papua New Guinea Institute of Medical Research and was one of the few centres in the developing world where population-based studies have been carried out. If its function was restored TRU could continue to provide information to assist the Department of Health in making decisions on appropriate interventions for improving the quality of life of the people of PNG and to evaluate new methods of disease control applicable in PNG as well as other parts of the world.

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TABLE 3

STAFF OF THE TARI RESEARCH UNIT IN NOVEMBER 1984

Director	Deborah Lehmann
Field Supervisor	John Vail
Health Extension Officer	Simon Kowi
Field Worker	Stephen Paija
Mortality Clerk	Raymond Deva
Research Clerks	Merilyn Lengo Hiru Olabe Maria Etai
Reporter Supervisors	Stephen Yawari Alia Warago Paul Komengi
Grade Three Reporters	Embetaiya Teiya Howard Puma Raymond Mai Agiru Teyabe Paragua Ekeya Bape Teiya Daniel Awe
Grade Two Reporters	John Tendeke Alembo Hali Kubiawi Habe
Grade One Reporters	Leonard Meria Buri Bora Hebe Wiliaba Mogai Andane Tayabe Lano Edward Kaloma Timothy Agilo Wabia Waga Madia Yera Yagari Parali Ignes Palawi Tamule Togola Lubia Timba Kamia Wayapuka Wabu Tabuko Mulungu Mobe
Driver	Philip Boko
Nightwatchman	Kambali Yuwa
Cleaner	Rose Halimbu
Mendi Computer Staff	
Systems Manager	Tony Mount
Keyboard Operator	Thomas Haguai

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