DEMOGRAPHY AND AGE-SEX DISTRIBUTION OF THE AUTOPSY POPULATIONS OF MULTIRACIAL SINGAPORE

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Although necropsy populations are rightly considered to be in many ways quite unlike the parent living population, and, indeed, the group of all deaths occurring in such a population, remarkably little effort has been made to define the differences. McMahan (1962), in his study of the age-sex distribution of selected groups of human autopsied cases in the United States of America, suggested that investigators utilising autopsy material might attempt to relate their population of autopsied cases to the death population, or to the hospital population, in terms of such characteristics as age, sex, and race, thus indicating gross selectivity.

If these studies are rare in the West, they are almost unknown in the East. In this report such data are presented for the several racial groups in the State of Singapore, viz. Chinese, Indians & Pakistanis, Malays, and Others, for the 5-year period 1954-1958.

THE STATE OF SINGAPORE

Singapore is an island of some 224.5 sq. miles which lies 1° 17' N. and 103° 50' E. Much of the island is low lying, considerable areas still being little more than mangrove swamp. The soil is on the whole poor, mainly laterite. A central granite outcrop, Bukit Timah Hill, forms the major physical prominence. On the southern tip of this island are the busy City and Port of Singapore. The island is connected to the Federation of Malaya by a road and rail causeway three-quarters of a mile long.

The marine equatorial climate is hot, moist, and equable. The average temperature is 85°F., the average relative humidity 83 percent. The mean annual rainfall is 95 inches. There are no seasons.

THE SINGAPORE POPULATION

When Thomas Stamford Raffles landed on Singapore Island in 1819 the population was in the region of 150 persons, all Bugis Malay. In 1824, when the Island was formally ceded, to the East India Company, the population had risen to 10,000. By 1860 the figure had increased to 81,734. The population at this time was principally Chinese, who had quickly realised the trading potential of the Port of Singapore (Wang, 1959). Free immigration continued, mainly from China and India, until about 1940. Over the years the Singapore Malay population has been augmented by migrants from contiguous Malaya and Indonesia. as well as by natural increase.

A Census of Population was held in mid 1957 when 1,445,929 persons were enumerated. Chinese were in the majority, 75 per cent of the total; Malays formed 14 per cent; Indians & Pakistanis, 9 per cent; and Others, i.e. Europeans, Eurasians, Ceylonese, Arabs, etc., 2 per cent. Some 54 per cent of this multiracial population was under 21 years of age: 18 per cent was under 5 years of age. (Chief Statistician, Singapore, 1959 a, b). Apart from a slight excess of males, the Chinese and Malay population distributions can be considered normal for this part of the world. The Indian & Pakistani population shows a twofold excess of males (Chua, Mitchell and Cheng, 1960) as such persons usually marry late in life, and tend to keep their families abroad. The European moiety of the population of Others has a peculiar distribution in that children over 10 years of age attend schools in Europe, and persons over 60 usually retire to their country of origin.

UTILISATION OF MEDICAL FACILITIES: ATTITUDES TO NECROPSY

The Singapore Government supports, from taxation, a comprehensive medical service. Those who so wish, can receive free medical advice at Dispensaries scattered throughout the Island, or from the Outdoor Dispensary at the General Hospital. If the patient's condition warrants, he will be referred to the appropriate service for further investigation, or for admission to the wards. Hospital consultation and treatment are also free. For

those wanting greater privacy, fee-paying beds are also available in the Government hospitals. There is therefore no reason why an ill person should not be admitted to hospital. Nevertheless there is great pressure on the available beds, and many are treated as out-patients who would probably be admitted to hospital in other parts of the world (Muir, 1963).

Despite these free facilities there is a considerable difference in the willingness of the various races in Singapore to be admitted to hospital. In 1954-1958, while 87 Indians & Pakistanis, and 96 Others, per 1,000 living were admitted to a Government Hospital, only 52 Chinese per 1,000 and 20 Malays per 1,000 were admitted (Muir, 1962).

Once admitted to hospital there is a reluctance on the part of Malays to permit biopsy and operation. There is a tendency on the part of all races to seek discharge from hospital if it seems likely that the patient will die, and hence come to necropsy.

As necropsy is much more likely to be performed if death takes place in hospital, the place of death is of some relevance. In 1954-1958, while 51 per cent of Chinese, 60 per cent of Indians & Pakistanis, and 58 per cent of Others died in hospital, only 19 per cent of Malays died there (Muir, 1962). There is a high degree of internal consistency in hospital admission and place of death data.

As will be shown, large numbers of Chinese children come to necropsy, because many Chinese parents do not wish to claim the bodies of their children for burial (Appendix I), and any body (other than that of a Muslim) not claimed within 24 hours of death can be necropsied if the attending physician so requests. Necropsies on adult Chinese are obtained with some difficulty.

Malays, being Muslims, find necropsy abhorrent, and were it not for the investigation by the Coroner of certain categories of death by necropsy, this examination would not be carried out on Malays. This statement holds good for Javanese, Boyanese, etc., who are mostly Muslims.

In general, permission for necropsy on Indian Hindoos is obtained with moderate difficulty. Indian & Pakistani Muslims give consent with greater reluctance, but these communities are not so uniformly opposed to necropsy as are Malays.

Of course, the usual factors of social standing, wealth and education all play a part in determining whether necropsy permission is given or not.

NECROPSY IN SINGAPORE

As elsewhere, necropsies in Singapore fall into two broad groups — (a) elective necropsy on patients dying in hospital, i.e. "ward cases", and (b) "Coroner's cases". For the former, necropsy permission is sought from the relatives of the deceased: in the second caetgory, the Coroner issues an order to the Government Pathologist to perform a necropsy on the deceased. Such an order is issued for unnatural, obscure, sudden and violent deaths. Many such orders are, of course, given for patients dying in hospital, e.g. following a motor accident. A considerable number of the "Coroner's cases", particularly those "found dead", or "brought in unconscious", die from natural causes such as coronary thrombosis, cancer or pneumonia.

Most necropsies are carried out at the mortuary of the General Hospital, Singapore. Necropsies on neonates and stillbirths are performed at the Kandang Kerbau Hospital (a hospital with maternity, neonatal, and gynaecology beds only) by the staff of this department. The protocols from all these necropsies are available to the writer.

It is estimated that the above sources comprise at least 95 per cent of all necropsies carried out in Singapore. This examination is relatively rare at Tan Tock Seng's (Tuberculosis) Hospital, at Woodbridge (Mental) Hospital, and at the Orthopaedic, Social Hygiene, Infectious Diseases, and Leprosy Hospitals. The Military Hospitals in Singapore cater largely for expatriate Service personnel, who are not included in the Census figures, and for a certain number of Malay soldiers. In private hospitals necropsy is virtually unknown.

THE SINGAPORE NECROPSY POPULATIONS

In 1954-1958, the period of survey, 11,736 necropsies were carried out at the mortuaries

of the General Hospital and the Kandang Kerbau Hospital. In this report 176 deaths from unknown causes, and deaths in unknown persons, have been excluded from the population of necropsied dead, but not from the population of total deaths. The 56 stillbirths necropsied were, of course, also excluded, leaving a grand total of 11,504 necropsies.

In Fig. 1 age-sex pyramids are given for the necropsy populations of the four main racial groups. Each pyramid represents 100 per cent of deaths in that particular race; males being on the left of the centre line; females on the right. All persons over 12 years of age possess an identity card which must be presented to obtain free hospital treatment. While this indicates age, it will be appreciated that the stated age is not always correct, especially in older persons.

The necropsies have further been divided into those in which the cause of death was natural, and those due to unnatural causes (solid black in the pyramids). Unnatural deaths are those due to accidents, poisoning, suicide and violence, i.e. those embraced by International List Nos. E 800-999 and N 800-999 (World Health Organisation, 1957).

Some 50 per cent of necropsies on dead Chinese were on children below five years of age. This astonishing figure partly reflects the large proportion of children in the living population. Further, as we have seen, many Chinese parents do not claim the bodies of their children for burial, such children being usually necropsied. The proportion of children necropsied in the Malay, Indian & Pakistani, and Others populations was very much smaller, 14, 14 and 13 per cent respectively, although the infant mortality rates for Malays, Indians & Pakistanis, and Others are considerably higher than for Chinese. These were, in 1958, for Chinese, 35.3 per 1,000 live births, for Malays, 85.5 per 1,000 live births, for Indians & Pakistanis, 40.3 per 1,000 live births, and for Others, 43.3 per 1,000 live births (Chua, Mitchell and Cheng, 1960).

There was a steady increase in the number of male Chinese necropsied up to the age of 55 years, with slow diminution thereafter. This trend is not so obvious for female Chinese.

Most necropsies on Malays of both sexes took place between 20 and 54 years of age; most on Indians & Pakistanis, and Others, were on men aged 20-59 years, necropsies on women being fewer.

As there were fewer Indian & Pakistani women in the Singapore population than there were Indian & Pakistani men, and as there was a relative excess of older men in this racial group, it is far better to compare the percentage of dead necropsied if comparisons by age and sex, and for that matter race, are to be made.

In the age-sex pyramids of Fig. 2, the percentage of dead necropsied is given for the four main racial groups. As in Fig. 1, deaths ascribed to natural and unnatural causes are differentiated.

The pyramids in Fig. 2 are summarised in Table I where the percentage of dead necropsied in Singapore in 1954-1958 is given by race and sex for selected broad age groups. Figures are given for all causes (AC) and natural causes (NC). The comments that follow are based on both Fig. 2 and Table I.

The pyramids for the Chinese and Indians & Pakistanis have roughly the same shape. Those for Malays and Others differ considerably from this pattern, faintly resembling each other.

In the age group 0 to 4 years, nearly all necropsied deaths were ascribed to natural causes, irrespective of race. While about 40 per cent of dead Chinese were necropsied, the proportion of dead Indian & Pakistanis necropsied was only 10 per cent. Virtually no Malay children were necropsied, although, as previously noted, the Malay infant mortality rate in the period was at least twice that of the other racial groups.

From 5 to 24 years there was a considerable rise in the proportion of death due to unnatural causes, particularly in males. Nearly half of the Chinese, and almost 40 per cent of the Indians & Pakistanis in this group who died were necropsied.

From 25 to 44 years there was a noticeable increase in the proportion of necropsies ascribed to natural causes, even in Malays. Nevertheless with the exception of Others of both sexes and male Indians & Pakistanis

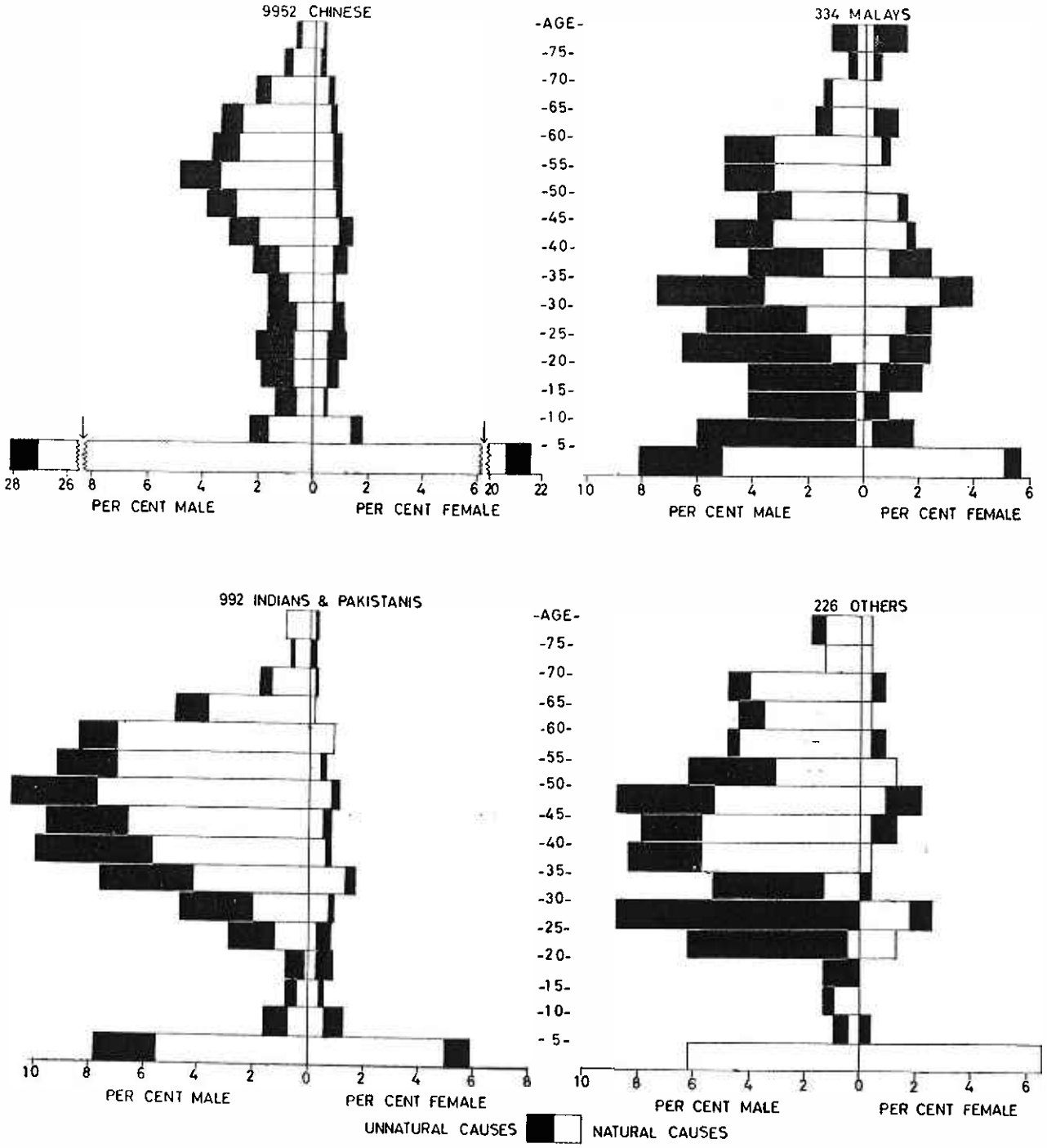

Fig. 1. Age-sex pyramids for the Singapore necropsy populations. Each pyramid represents 100 per cent of the deaths in that particular race. Deaths due to natural and unnatural causes are distinguished (See text).

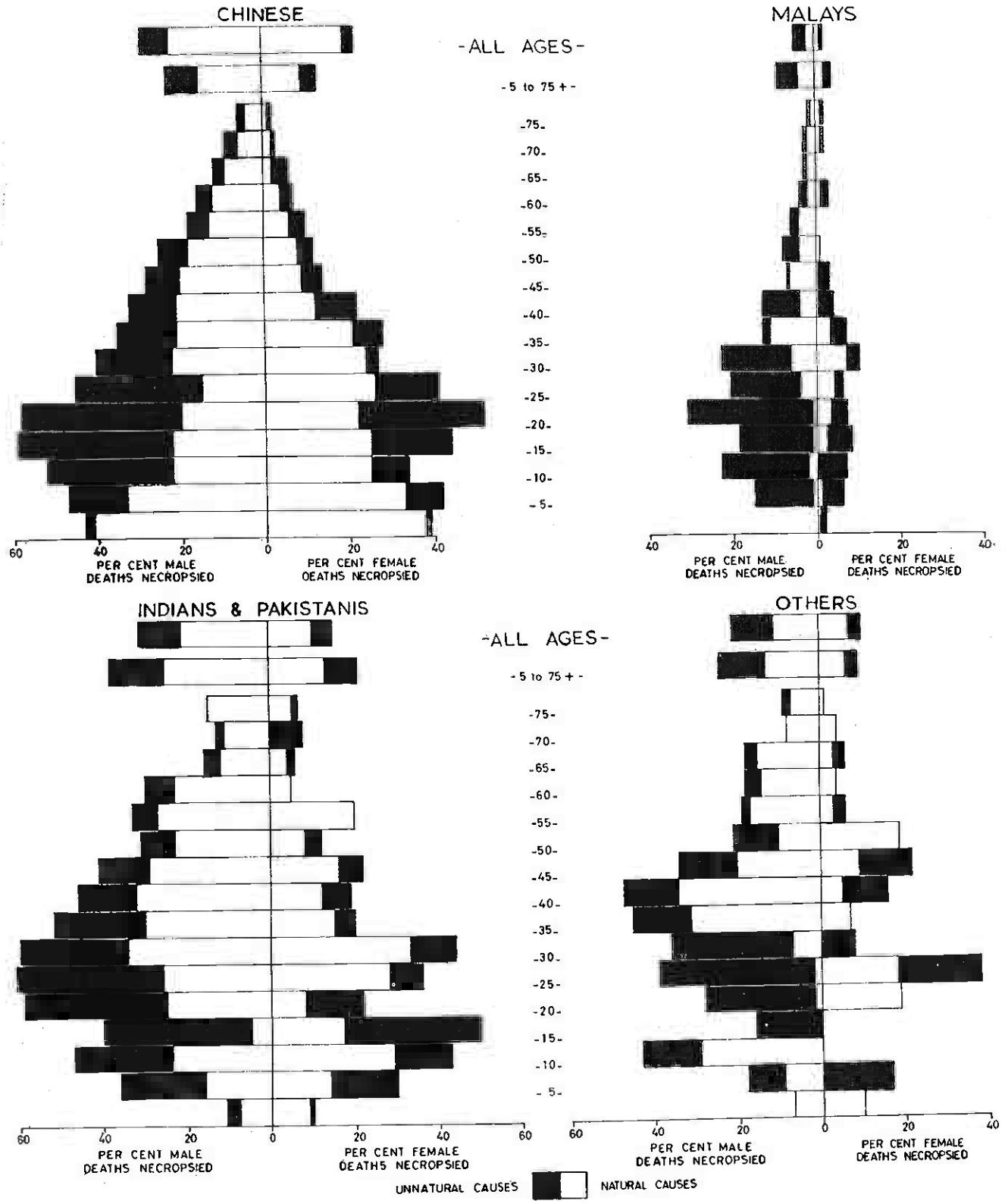

Fig. 2. Percentage of dead necropsied in Singapore in 1954-1958 by race, sex, and five year age group. As in Fig. 1, deaths due to natural and unnatural causes are distinguished.

TABLE I.

PERCENTAGE OF DEAD NECROPSIED IN SINGAPORE IN 1954-1958 (AC), AND PERCENTAGE OF DEAD NECROPSIED WHOSE DEATHS WERE ASCRIBED TO NATURAL CAUSES (NC), BY SEX, RACE, AND SELECTED AGE GROUPS.

	MALES													
AGE GROUP	0-4		5-24		25-44		45-64		65 +		All ages		45 +	
Death category / Race	AC	NC	AC	NC	AC	NC	AC	NC	AC	NC	AC	NC	AC	NC
CHINESE	42.6	41.1	53.3	25.0	36.1	20.2	21.1	15.2	9.3	6.8	28.9	22.4	16.9	12.2
MALAYS	0.9	0.6	20.6	2.1	16.9	7.8	5.9	3.9	2.3	1.2	4.5	1.9	4.6	3.0
INDIANS & PAKISTANIS	10.7	7.6	46.6	18.3	53.0	30.9	34.1	25.8	14.7	12.6	30.9	20.5	30.4	23.3
OTHERS	7.3	7.3	25.3	4.6	41.6	16.2	22.8	15.4	12.5	10.4	21.0	11.4	19.0	13.5
	FEMALES													
CHINESE	39.2	37.5	43.2	27.7	27.6	18.3	10.4	7.3	3.6	2.2	22.2	18.7	6.7	4.5
MALAYS	0.8	0.7	6.7	1.7	6.7	4.2	1.8	1.1	1.5	0.4	2.2	1.2	1.7	0.8
INDIANS & PAKISTANIS	10.1	8.6	32.1	14.3	28.6	21.1	15.1	12.4	7.1	3.5	15.2	10.9	12.1	9.1
OTHERS	9.9	9.9	14.8	11.1	18.0	9.8	11.1	7.1	3.1	2.3	9.5	7.2	6.6	4.4

TABLE II.

COMPARISON, BY SEX, OF THE OBSERVED NUMBER OF NECROPSIES (ALL CAUSES) ON DEAD INDIANS & PAKISTANIS, WITH THE NUMBERS TO BE EXPECTED IF THEY EXPERIENCED THE SAME AGE-SPECIFIC NECROPSIED DEAD RATES AS CHINESE FOR (a) ALL AGES (b) 5 YEARS AND OVER.

Sex	(a) All ages.		(b) 5 years and over	
	Observed No.	Expected No.	Observed No.	Expected No.
M	819	834	742	527 *
F	173	345 *	114	116

* Significant difference $P < 0.01$.

TABLE III.

COMPARISON OF THE OBSERVED NUMBER OF NECROPSIES FROM UNNATURAL CAUSES, BY RACE AND SEX, WITH THE NUMBER TO BE EXPECTED FOR EACH RACE AND SEX IF THE WHOLE NECROPSY POPULATION OF UNNATURAL DEATHS WERE HOMOGENEOUS.

Race	Sex	Observed No.	Expected No.
Chinese	M	1,434	1,376
	F	566	468 *
Malays	M	137	264 *
	F	43	147 *
Indians & Pakistanis	M	276	208 *
	F	49	39
Others	M	83	81
	F	11	15
Total		2,599	2,598

* Significant difference $P < 0.01$.

there was a decline in the overall proportion of dead necropsied. Nearly a third of the dead male Chinese and just over half of the dead male Indian & Pakistanis were necropsied. A relatively high proportion of the deaths in Malay women, classed as natural causes, followed childbirth, or the complications of childbirth, as many of these women are not taken for treatment until moribund.

From 45 to 64 years, while the percentage of dead necropsied fell for both sexes in all racial groups, the proportion of those necropsies ascribed to natural causes continued to rise. Roughly one third of male Indian & Pakistani dead were necropsied, three quarters of those necropsied revealing natural disease processes. Corresponding ratios for male Chinese were one-fifth and three-quarters. The proportion of dead female Chinese and Indians & Pakistanis necropsied was about half of the corresponding male figure. The number and proportion of dead Malays necropsied was negligible.

In the age group 65 and over, a smaller proportion of the dead of all races were necropsied than in the age group 45-64 years. The higher proportion of dead Indians & Pakistanis of both sexes necropsied is outstanding, albeit numbers are relatively small. The majority of necropsies, Malays excepted, revealed natural causes of death.

There is a striking deficit of Malays in the necropsy population, and it is obvious that the necropsy experience of this racial group is quite unlike the others. However, the age-sex pyramids of Chinese, and Indian & Pakistanis, are not too dissimilar, especially if children under 5 years of age are disregarded. It would be of interest to find out if the Chinese and Indian & Pakistani populations could be compared directly. To this end 5 year age-specific rates for the number of dead Chinese necropsied were calculated, by sex. These rates were then applied to the number of dead Indians & Pakistanis in each 5 year age-group, and the expected numbers so obtained compared with the actual, (a) for all ages, and (b) for those aged 5 years and over. Assuming that a Poisson distribution holds, differences are held to be significant if the expected number differs by more than three standard deviations ($3\sqrt{\text{expected numbers}}$) from the observed. The results given in Table II indicate that there are significant differences between the two populations.

As the necropsies on persons dying from unnatural causes are all ordered by the Coroner, there is a greater likelihood that this part of the necropsy population will be homogeneous. This hypothesis has been tested, and the results in Table III indicate that Malays of both sexes, male Indians and Pakistanis, and female Chinese differ significantly from expectation. (The reasons for these differences lie outwith the scope of this report). The use of the whole population of unnatural deaths for controls in any investigation involving persons of different race would therefore be unwise.

COMMENT

The several racial groups that make up the Singapore population would seem to have not only their own languages, customs, dress, and foods, but also individual patterns of necropsy.

In general, the trends observed are similar to those described by McMahan (1962) for selected populations of the southern parts of the United States of America. Dead males are more likely to be necropsied than dead females, a tendency that persists at practically all five year age groups. The proportion of dead necropsied seems to decline after the age of 30 years, and older persons are least likely to be necropsied.

McMahan (1962) felt that among those dying under the age of 40 years, those in the "teenages" were least likely to be necropsied. This generalisation certainly does not hold for Singapore Chinese.

The high proportion of dead necropsied in Singapore, 22.1 per cent in 1954-1958, should improve the accuracy of mortality statistics. This proportion is slightly higher than that obtaining in the United States of America, where, in 1955, 17.8 per cent of death certificates indicated that an autopsy had been performed (McMahan, 1960).

Necropsy data related to a definite population are generally not available within Asia. The excellent necropsy data in Taipeh, Taiwan, are not readily related to the population at

large (Yeh, 1964). To the best of the writer's knowledge, no Indian or Ceylonese necropsy population has been so characterised.

Migrant Chinese communities are to be found in several parts of the world. In Hawaii, in 1954-1958, 18.5 per cent of dead male, and 15.1 per cent of dead female Chinese were necropsied. The overall proportion necropsied, 17.5 per cent, was some 15 per cent lower than for the State of Hawaii as a whole. (Quisenberry, 1964). Unfortunately the California Tumor Registry, which has data on Californian Chinese, lacks, as yet, a population basis (Linden, 1964).

In general, the proportion of deaths necropsied in Singapore is much too low for accurate epidemiological studies. Further, data from Malays and Others are probably grossly biased.

Nevertheless, useful information can still be derived from necropsy material. For example, primary liver cancer would seem to be relatively much more frequent in necropsied China born Chinese than in a peer group of Singapore born Chinese (Shanmugaratnam, 1956), and there is a striking excess of male Indian and Pakistanis with fatal coronary heart disease when compared to Chinese men (Muir, 1960).

SUMMARY

The age distribution of 11,504 dead persons necropsied in Singapore in the five years 1954-1958 is given by race and sex.

The percentage of all deaths necropsied is given by race, sex, and five year age-group, and for selected broad age-groups. Natural and unnatural deaths are distinguished. Some 28.9 per cent of dead male, and 22.2 per cent of dead female Chinese were necropsied. Corresponding figures for Malays, Indians & Pakistanis, and Others, are, 4.5 and 2.2 per cent, 30.9 and 15.2 per cent, and 21.0 and 9.5 per cent.

Dead males are more likely to be necropsied than dead females, the proportion of dead necropsied declines after the age of 30 years and the elderly are least likely to be necropsied. A very high proportion of dead Chinese children are necropsied.

The homogeneity of the various necropsy populations has been tested. Significant differences exist between the various racial groups, even for those necropsies ordered by the Coroner.

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APPENDIX I

Failure of Chinese parents to claim the bodies of their dead children.

I am indebted to Dr. A. L. Gwee, Senior Physician, Singapore, for the following information.

In the Chinese Buddhist culture, where filial piety is a cardinal virtue, one of the duties of a child is to attend the funeral of his parents. Obviously a dead child cannot do this, and the delinquent soul of such a child would be dealt with severely in Hades. To safeguard the child from such punishment the child is abandoned, and thus when his soul appears in Hades he can truthfully say that he does not know who his parents are.

On occasion, when the body is claimed, the coffin is struck with a stick several times to punish the child within. The parents then leave the interment to others, abandoning the child, but knowing that his guilt has already been expiated, and that no further punishment awaits him.

These ceremonies are not necessary for stillbirths which are held to have no soul.

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