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Diabetes Mortality in Singapore, 1991 – A Preliminary Study

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ABSTRACT

Objectives: The study was undertaken to estimate the contribution of diabetes mellitus to total mortality in Singapore and to study the mortality experience among known diabetics in Singapore by sex, age-group and ethnic group.

Methods: Death certificates of all persons who died in Singapore between 1 January 1991 and 31 August 1991 (n = 9,197) were reviewed. Records which mentioned diabetes mellitus as an underlying or contributory cause of death were selected as being a diabetic case (n = 1,010).

Results: If all diabetes related deaths were considered, diabetes mellitus would account for 9.3% of all deaths in Singapore in 1991, ie. four times higher than the figure of 2.3% in the official statistics. Ischaemic heart disease was the leading cause of death in all age-groups. Renal failure was a major cause of death before the age of 55 while cerebrovascular disease and respiratory tract infections were important causes of death after the age of 64. Renal failure was the leading cause of death among Chinese diabetics below the age of 65. Ischaemic heart disease was the main cause of death among Indian and Malay diabetics. As compared to the general population, Chinese diabetics were more likely to die from renal failure while Indian and Malay diabetics were more likely to die from ischaemic heart disease.

Keywords: diabetes mortality, ethnic

INTRODUCTION

The mortality reporting system adopted by the World Health Organisation selects only one cause of death for the tabulation of mortality statistics. This is the underlying cause of death which was defined as[3]: "the disease or injury which initiated the train of morbid events leading directly to the death, or the circumstances of the accident or violence which produced the fatal injury".

The concept of the underlying cause of death is that if the starting point of a sequence of death is known, death can be postponed by preventing the initiating cause from operating.

The chronic complications of diabetes are well recognised. There is progressive damage to the nerves, eyes, kidneys and arteries[1]. Most diabetics die from the complications of the disease; coronary heart disease, cerebrovascular disease and end-stage renal failure being the chief causes of death. Other causes of death include septicaemia from infections such as pneumonia and urinary tract infections. Far less common as a cause of death is diabetic ketoacidosis.

However, the contribution of diabetes towards mortality is grossly underestimated in the official mortality statistics. The underlying cause of death in diabetics who die from cardiovascular diseases or septicaemia is not taken to be diabetes but the cardiovascular disease itself or the infection which caused the septicaemia.

In Singapore, the only causes of death in diabetics in which diabetes will be selected as the underlying cause are:

(a) diabetes mellitus, no other disease specified;
(b) diabetic ketoacidosis/ hyperosmolar non-ketotic coma;
(c) septicaemia from diabetic gangrene,
(d) end-stage renal failure/chronic renal failure from diabetic nephropathy or in a patient with a long history of diabetes.

Table I shows the distribution of the ten leading causes of death in Singapore in 1991, and their proportionate contribution towards total mortality[2]. In 1991, diabetes ranked sixth as an underlying cause of death in Singapore. As a proportion of all deaths, it was responsible for a relatively low 2.3% of the total. This small figure obscures the importance of diabetes mellitus as a major contributor of mortality in Singapore.

A study was therefore done to:

(1) provide an estimate of the contribution of diabetes mellitus towards total mortality in Singapore;
(2) determine the major causes of death among diabetics in Singapore (excluding injuries and other external causes) and thus further our understanding of the natural history of diabetes mellitus in the local context;
(3) determine if diabetics in Singapore experience excess mortality from particular causes of death,
(4) assess whether there are any differences in the mortality experience among the different sexes, age-groups and ethnic groups in Singapore.

METHODS

In Singapore, the particulars of the deceased and the causes of death as recorded on the Certificate of Cause of Death (CCOD) are transferred to a

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Table I – Leading causes of death in Singapore, 1991

Rank	Cause of death (ICD-9 codes)	No.	%
	All causes	**13,876**	**100.0**
1	Malignant neoplasms (140 – 208)	3,361	24.2
2	Ischaemic heart disease (410 – 414)	2,515	18.1
3	Cerebrovascular disease (430 – 438)	1,700	12.3
4	Pneumonia (480 – 486)	1,285	9.3
5	Injuries & poisoning (E810 – 999)	1,074	7.7
6	Diabetes mellitus (250)	320	2.3
7	Nephritis, nephrotic syndrome and nephrosis (580 – 589)	246	1.8
8	Congenital anomalies (740 – 759)	164	1.2
9	Bronchitis, emphysema & asthma (490 – 493)	156	1.1
10	Septicaemia (038)	142	1.0

Source: Report on registration of Births & Deaths, 1991, Registry of Births and Deaths, National Registration Department, Singapore.

Statistical Report Form for the Certification of Death before entry into a computerised database for the recording of death registration and tabulation of national mortality information.

For the purposes of this study, the Statistical Report Forms for Certification of Death of all 9,197 deaths which occurred between 1 January 1991 and 31 August 1991 (inclusive) were studied. The original Report Forms kept in the Registry of Births and Deaths were reviewed and not computerised data.

Selection of the study population

All stated diabetics who died between 1 January 1991 and 31 August 1991 (inclusive) formed the study population. Diabetics who had died from injuries eg. motor vehicle accidents and other external causes were excluded. All causes of death which were recorded on the Statistical Report Forms were carefully reviewed. Records with any mention of diabetes mellitus, diabetic ketoacidosis, hyperosmolar non-ketotic coma, diabetic nephropathy or diabetic gangrene were selected as being a known diabetic case. Using this method, 1,010 diabetic cases were identified and selected to form the study population.

Data on the age (calculated from the date of birth and death and recorded in completed years), sex, race, reported duration of diabetes and attributed cause of death of each diabetic case were recorded. In the categorisation of race, "Malays" included Javanese and Boyanese, "Indians" included Ceylonese and Sikhs while "Others" consisted of Eurasians and Caucasians. Causes of death were then coded using the 9th revision of the International Classification of Diseases (ICD) published by the World Health Organisation[3].

Estimation of the contribution of diabetes mellitus to total mortality

Cases in which diabetes was a contributory cause in conditions where diabetes could conceivably play a part were added to cases in which diabetes was assigned as the underlying cause of death. These "diabetes related deaths" consisted of:

(a) diabetes mellitus, no other cause stated
(b) diabetic ketoacidosis
(c) diabetic nephropathy
(d) chronic/end-stage renal failure and diabetes
(e) gangrene of the extremities and diabetes
(f) acute myocardial infarction/ischaemic heart disease and diabetes
(g) cerebrovascular disease and diabetes
(h) septicaemia/infections and diabetes

Diabetics who had died from totally unrelated conditions eg. cancer and injuries were excluded in the computation.

Derivation of Observed/Expected ratios for specific causes of deaths

The age and sex-specific proportion of total mortality for a specific cause of death in the general Singapore population for 1991[2] was applied to the number of diabetics in each age, sex and ethnic stratum to obtain the "Expected" number of deaths. Expected numbers of deaths were rounded up to the nearest whole number. Diabetics were age-stratified in two broad age-groups ie. those below 65 years of age and those 65 years and above. As there were only three deaths in the study population below the age of 40 years, the lower age limit for the general population was taken to be 40 years. The age strata for the general population consisted therefore of two groups, 40 – 64 years and 65 years and above.

The "Observed" number of deaths among stated diabetics in each stratum was then divided by the Expected number to yield "Observed/Expected" ratios for each specific cause of death. Five specific causes of death were selected for the computation of Observed/Expected ratios: ischaemic heart disease, cerebrovascular disease, end-stage/chronic renal failure, pneumonia and cancer.

The number of diabetics who had died from renal failure in each age and sex stratum was added to the number of deaths in the general population from end-stage/chronic renal failure (nephritis, nephrosis and nephrotic syndrome) as reported in the official mortality statistics[2] to obtain the total number of deaths from end-stage/chronic renal failure. This is because diabetics who had died from end-stage/chronic renal failure were classified as having died from diabetes.

Generalisability of deaths occurring between January – August 1991 to all deaths in 1991

To see whether the results for the period 1 January – 31 August 1991 could be generalised to all deaths which had occurred in the whole year of 1991, the sex-specific age, ethnic group and selected cause of death distribution of the two periods were compared and found to be nearly identical. The results from the 8-month period can therefore be validly generalised to that for 1991 as a whole.

Statistical analysis

As the study was descriptive in nature and no hypotheses were tested, data analysis for statistical significance was not performed.

RESULTS

Biographic profile

The age at death and ethnic group distribution of the diabetic study population is shown in Table II. There were proportionately more females (55.6%, n = 562) than males (44.4%, n = 448). This is probably explained by the females being generally older at the time of death. Diabetes, in particular non-insulin dependent diabetes is more prevalent as age increases[5]. It can be assumed that nearly all diabetics in the study population were of the non-insulin dependent category as insulin-dependent diabetes is quite rare in the Singapore population[5]. Female diabetics in the study population were as expected, generally older than male diabetics (median age of death – 72 years vs 67 years).

Most of the subjects (97.3% of males and 99.3% of females) were aged 45 years or older at the time of death. Of the 12 male diabetics who were below 45 years of age, 9 were between the ages of 40 and 44 years while one died in his thirties and two died at 29 years of age. Of the female diabetics who were below the age of 45 years, all were aged 40 years and above.

Table II – Age at death and ethnic group distribution of stated diabetics by sex (January – August 1991)

	Male		Female		Total	
	No.	%	No.	%	No.	%
All subjects	448	100.0	562	100.0	1,010	100.0
Age distribution						
< 45 years	12	2.7	4	0.7	16	1.6
45 – 54	45	10.0	31	5.5	76	7.5
55 – 64	122	27.2	107	19.0	229	22.7
65 – 74	152	33.9	206	36.7	358	35.4
⩾ 75	117	26.1	214	38.1	331	32.8
Mean age (years)	67.1		70.9		69.2	
Median age (years)	67.0		72.0		70.0	
Ethnic group						
Chinese	299	66.7	413	73.5	712	70.5
Malay	72	16.1	100	17.8	172	17.0
Indian	69	15.4	44	7.8	113	11.2
Others	8	1.8	5	0.9	13	1.3

Table III – Age distribution of stated male and female diabetics by ethnic group (January – August 1991)

	Chinese		Malay		Indian	
	No.	%	No.	%	No.	%
Males						
All ages	299	100.0	72	100.0	69	100.0
< 55 years	32	10.7	12	16.7	13	18.8
55 – 64	72	24.1	29	40.3	21	30.4
65 – 74	98	32.8	23	31.9	23	33.3
⩾ 75	97	32.4	8	11.1	12	17.4
Mean age	68.6 yrs		63.5 yrs		64.4 yrs	
Median age	70 yrs		63 yrs		65 yrs	
Females						
All ages	413	100.0	100	100.0	44	100.0
< 55 years	13	3.1	17	17.0	5	11.4
55 – 64	61	14.8	31	31.0	14	31.8
65 – 74	150	36.3	38	38.0	17	38.6
⩾ 75	189	45.8	14	14.0	8	18.2
Mean age	73.1 yrs		64.0 yrs		66.1 yrs	
Median age	74 yrs		65 yrs		66.5 yrs	

The proportion of Indian male diabetics in the male study population (15.4%) was more than twice the proportion of Indian males in the general population (7.5%). This corresponds with the much higher prevalence of diabetes mellitus among Indians in Singapore as compared to Chinese and Malays. This pattern was reported in all three population surveys in Singapore in 1975[4],1983 – 84[5] and 1992[6].

The age distribution of the diabetic study population was further studied by stratifying by ethnic group (Table III) to see if there were major differences in the age distribution among the three main ethnic groups. Overall, the Chinese diabetics were older than their Malay and Indian counterparts. Indian diabetics were slightly older than Malay diabetics. The median ages at death for Chinese diabetics were 70 years for males and 74 years for females as compared to Malay diabetics (male = 63 years, female = 65 years) and Indian diabetics (male = 65 years, female = 66.5 years).

Diabetes-related deaths

Not all deaths that occurred among diabetics can be attributed to diabetes or its complications. This is because some of the deaths would have been due to unrelated causes such as cancer, injuries and liver cirrhosis. Diabetics who died from injuries had already been excluded from the study population.

To ascertain the proportion of deaths from all causes which could be ascribed to diabetes mellitus or its complications, ie. "diabetes-related deaths", deaths which were due to the conditions listed in the Methods section earlier were enumerated (Table IV). A total of 855 diabetics in the study population had died from diabetes related deaths. Extrapolating to all deaths which had occurred during the study period (1 January to 31 August 1991), it can be inferred that 855 out of the total 9,197 deaths or 9.3% can be attributed as being due to diabetes or its complications.

This figure of 9.3% would make diabetes mellitus the fourth leading cause of death in the Singapore population after malignant neoplasms, ischaemic heart disease and cerebrovascular disease.

Causes of death among diabetics in Singapore

By sex and age (Table V)

It was found that the main causes of death in both male and female diabetics were similar. The leading cause of death was ischaemic heart disease (28.3% of deaths in male diabetics and 29.9% in females), followed by cerebrovascular disease (18.1% in males and 17.6% in females) and end-stage/chronic renal failure (10.0% in males and 10.3% in females). Thus, cardiovascular disease (ischaemic heart and cerebrovascular diseases) accounted for nearly half of all deaths in the diabetic study population.

Infections were also a leading cause of death. Taking all infections together, they were responsible for one-fifth (20.3% in males and 21.9% in females) of all deaths in the diabetic study population. The

Table IV – Diabetes-related deaths among stated diabetics (January – August 1991)

Underlying cause of death (ICD-9 codes)	No.	%
Diabetes mellitus, no other condition mentioned (2500)	16	1.6
Diabetic ketoacidosis (2501)	17	1.7
Hyperosmolar coma (2502)	1	0.1
Diabetic gangrene (2506)	27	2.7
Ischaemic heart disease (410-414)	295	29.2
Cerebrovascular disease (430-438)	180	17.8
Chronic renal failure (585)	103	10.2
All infections	216	21.4
– Septicaemia (038)	25	2.5
– Respiratory tract (011,485-6,510)	128	12.8
– Renal/ Urinary tract (590, 5990)	28	2.8
– Skin (680,682,7070)	20	2.0
– Other infections (018,025,320,575-577,711)	15	1.5
TOTAL	855	85.5

Table V – Percentage distribution of causes of death among stated diabetics by sex and age group (January – August 1991)

Cause of death	Percentage distribution in age-group				
Males	**< 55 (n=57)**	**55 – 64 (n=122)**	**64 – 74 (n=152)**	**≥ 75 (n=117)**	**All ages (n=448)**
Diabetes, no other condition mentioned	-	0.8	0.7	1.7	0.9
DKA/HHNK	5.3	0.8	0.7	1.7	1.6
Diabetic gangrene	3.5	2.5	2.0	1.7	2.2
Ischaemic heart disease	26.3	29.5	28.9	27.4	28.3
Cerebrovascular disease	12.3	17.2	21.1	17.9	18.1
Chronic renal failure	22.8	12.3	7.9	4.3	10.0
All infections	12.3	14.8	21.7	28.2	20.3
– Septicaemia	3.5	2.5	2.6	3.4	2.9
– Respiratory tract	3.5	8.2	13.2	19.7	12.3
– Renal/Urinary tract	-	1.6	5.3	1.7	2.7
– Skin	1.8	2.5	0.7	1.7	1.6
– Other infections	3.5	-	-	1.7	1.3
Cancer	8.8	7.4	8.6	9.4	8.5
Other causes	8.8	14.8	8.6	7.7	10.0
Females	**< 55 (n=35)**	**55 – 64 (n=107)**	**65 – 74 (n=206)**	**≥ 75 (n=214)**	**All ages (n=562)**
Diabetes, no other condition mentioned	2.9	2.8	1.5	2.3	2.1
DKA/HHNK	5.7	-	2.4	1.9	2.0
Diabetic gangrene	-	4.7	2.9	2.8	3.0
Ischaemic heart disease	31.4	29.0	31.1	29.0	29.9
Cerebrovascular disease	14.3	21.5	17.5	16.4	17.6
Chronic renal failure	22.9	18.7	8.3	6.1	10.3
All infections	8.6	15.0	20.9	28.5	21.9
– Septicaemia	-	1.9	1.9	2.8	2.1
– Respiratory tract	-	5.6	11.7	20.1	13.2
– Renal/Urinary tract	2.9	1.9	2.9	3.3	2.8
– Skin	2.9	2.8	2.4	1.9	2.3
– Other infections	2.9	2.8	2.0	0.5	1.5
Cancer	2.9	4.7	7.3	4.7	5.5
Other causes	11.4	3.7	8.3	8.4	7.7

most common type of infection was respiratory tract infections (mainly pneumonia).

An analysis among the different age-groups showed that deaths from diabetic ketoacidosis and end-stage/chronic renal failure were far commoner in the youngest age groups (those younger than 55 years of age) than those in the older age groups.

The proportion of deaths from cerebrovascular disease was more common in the older age groups, as were deaths from respiratory tract infections.

By ethnic group (Table VI)

The distribution of causes of deaths among Chinese, Malay and Indian diabetics was also studied. As the distribution of age at death among the different ethnic groups was dissimilar, they were stratified into two broad age groups: those under the age of 65 years and those who were 65 years and older.

A lower proportion of Chinese diabetics died from ischaemic heart disease as compared to their Malay or Indian counterparts. Indian female diabetics under the age of 65 years recorded the highest proportion of deaths from ischaemic heart disease (52.6%). In comparison, only 23.0% of Chinese female diabetics and 29.2% of Malay female diabetics similarly aged died from the disease.

It was also found that one-quarter of Chinese male and female diabetics under the age of 65 died from end-stage/chronic renal failure while only 2.4% of male and 16.7% of female Malay diabetics and 2.9% of Indian males and 10.5% of Indian females of similar age group had died from renal failure.

With regards to deaths which had resulted from cerebrovascular disease, there was a higher proportion of Malay diabetics under the age of 65 who had died from it (male: 22.0% and female: 25%) as compared to Chinese (male: 13.5% and female: 18.9%) and Indians (male: 14.7%, female: 10.5%). There was not much difference among the three ethnic groups above the age of 65.

Observed/Expected ratios for specific underlying causes of death by sex, age group and ethnic group

The mortality experience of diabetics versus the general population with regards to specific underlying causes of death were compared. Observed/ expected (O/E) ratios were calculated for the following five causes of death:

- Ischaemic heart disease
- Cerebrovascular disease
- Renal failure
- Pneumonia
- Cancer

The results are tabulated in Tables VII and VIII.

All ethnic groups

The O/E ratios for deaths from cerebrovascular disease was a uniform 1.6 for all groups except among female diabetics 65 years and over, demonstrating that diabetes is a risk factor for fatal cerebrovascular disease in the local population. It was also observed that male diabetics, particularly those aged under 65 years, were more likely to die from pneumonia than the male general population of similar age.

It was observed that the O/E ratios for deaths from cancer in general were very low, ranging from 0.1 to 0.4. This is most likely due to under-reporting of diabetes in deaths due to cancer. Since the Certificate of Cause of Death only requires the physician to record "significant conditions which contributed to death", diabetes would in most cases, not be seen as a condition which had contributed to deaths due to cancer.

Table VI – Percentage distribution of causes of death among stated diabetics by age group and ethnic group (January – August 1991)

Cause of death	Age < 65 years			Age > 65 years		
Males	**Chinese (n=104)**	**Malay (n=41)**	**Indian (n=34)**	**Chinese (n=195)**	**Malay (n=31)**	**Indian (n=35)**
Diabetes, no other condition specified	1.0	-	-	1.5	-	-
DKA/HHNK	-	4.9	5.9	1.5	-	-
Diabetic gangrene	2.9	4.9	-	2.6	-	-
IHD	24.0	31.7	38.2	23.1	48.4	40.0
Cerebrovascular disease	13.5	22.0	14.7	21.0	16.1	17.1
Chronic renal failure	25.0	2.4	2.9	4.6	16.1	2.9
All infections	8.7	22.0	20.6	26.7	16.1	22.9
Cancer	12.5	-	2.9	10.8	-	5.7
Other causes	12.5	12.2	14.7	8.2	3.2	11.4
Females	**Chinese (n=74)**	**Malay (n=48)**	**Indian (n=19)**	**Chinese (n=339)**	**Malay (n=52)**	**Indian (n=25)**
Diabetes, no other condition specified	4.1	2.1	-	1.8	3.8	-
DKA/HHNK	-	4.2	-	2.1	1.9	4.0
Diabetic gangrene	4.1	4.2	-	2.4	7.7	-
IHD	23.0	29.2	52.6	29.2	30.8	40.0
Cerebrovascular disease	18.9	25.0	10.5	16.5	17.3	20.0
Chronic renal failure	24.3	16.7	10.5	7.1	3.8	12.0
All infections	14.9	10.4	15.8	26.0	23.1	16.0
Cancer	6.8	2.1	-	6.2	3.8	4.0
Other causes	4.1	6.3	10.5	8.8	7.7	4.0

Table VII – Observed/Expected ratios for specific underlying causes of death among stated diabetics aged 40 – 64 years by ethnic group (January – August 1991)

Males	Chinese (n=104)			Malay (n=41)			Indian (n=34)			Total (n=179)		
Cause of death	**O**	**E**	**O/E**	**O**	**E**	**O/E**	**O**	**E**	**O/E**	**O**	**E**	**O/E**
IHD	25	24	1.0	13	9	1.4	13	8	1.6	51	41	1.2
Stroke	14	10	1.4	9	4	2.3	5	3	1.7	28	17	1.6
Renal failure	26	4	6.5	1	1	*	1	1	*	28	6	4.7
Pneumonia	2	4	0.5	4	2	2.0	5	1	5.0	11	7	1.6
Cancer	13	33	0.4	0	13	*	1	11	*	14	57	0.2
Females	**Chinese (n=74)**			**Malay (n=48)**			**Indian (n=19)**			**Total (n=141)**		
	O	**E**	**O/E**	**O**	**E**	**O/E**	**O**	**E**	**O/E**	**O**	**E**	**O/E**
IHD	17	12	1.4	14	8	1.8	10	3	3.3	41	23	1.8
Stroke	14	9	1.6	12	6	2.0	2	2	1.0	28	18	1.6
Renal failure	18	5	3.6	8	3	2.7	2	1	2.0	28	9	3.1
Pneumonia	4	3	1.3	0	2	*	2	1	2.0	6	6	1.0
Cancer	5	26	0.2	1	17	*	0	7	*	6	50	0.1

O : Observed no. of deaths; E : Expected no. of deaths; * : not calculated
Males : E calculated by applying following proportions : IHD (586/2567), Stroke (237/2567), Renal failure (87/2567), Pneumonia (98/2567), Cancer (813/2567)
Females : E calculated by applying following proportions : IHD (231/1433), Stroke (183/1433), Renal failure (96/1433), Pneumonia (59/1433), Cancer (512/1433)

Table VIII – Observed/Expected ratios for specific underlying causes of death among stated diabetics aged ≥ 65 years by ethnic group (January – August 1991)

Males	Chinese (n=195)			Malay (n=31)			Indian (n=35)			Total (n=261)		
Cause of death	**O**	**E**	**O/E**	**O**	**E**	**O/E**	**O**	**E**	**O/E**	**O**	**E**	**O/E**
IHD	45	39	1.2	15	6	2.5	14	7	2.0	74	52	1.4
Stroke	41	24	1.7	5	4	1.3	6	4	1.5	52	32	1.6
Renal failure	9	5	1.8	5	1	5.0	1	1	*	15	6	2.5
Pneumonia	31	23	1.3	5	4	1.3	5	4	1.3	41	31	1.3
Cancer	21	49	0.4	0	8	*	2	9	0.2	23	65	0.4
Females	**Chinese (n=339)**			**Malay (n=52)**			**Indian (n=25)**			**Total (n=416)**		
	O	**E**	**O/E**	**O**	**E**	**O/E**	**O**	**E**	**O/E**	**O**	**E**	**O/E**
IHD	99	69	1.4	16	11	1.5	10	5	2.0	125	85	1.5
Stroke	56	62	0.9	9	10	0.9	5	5	1.0	70	76	0.9
Renal failure	24	12	2.0	2	2	1.0	3	1	3.0	29	14	2.1
Pneumonia	59	45	1.3	5	7	0.7	1	3	*	65	56	1.2
Cancer	21	62	0.3	2	10	0.2	1	5	0.2	24	76	0.3

Males : E calculated by applying following proportions : IHD (839/4229), Stroke (513/4229), Renal failure (98/4229), Pneumonia (499/4229), Cancer (1051/4229)
Females : E calculated by applying following proportions : IHD (822/4041), Stroke (739/4041), Renal failure (138/4041), Pneumonia (541/4041), Cancer (743/4041)

By ethnic group and cause of death

Ischaemic heart disease

Indian diabetics were found to have the highest O/E ratios (1.6 to 3.3) followed by Malay (O/E ratios 1.4 to 2.5) and Chinese diabetics (1.0 to 1.4). Indian and Malay diabetics are thus at higher risk of dying from ischaemic heart disease as compared to the general population. This observation corresponded well with the pattern of deaths from ischaemic heart disease observed in the general Singapore population ie. highest among the Indians and lowest among the Chinese.

Cerebrovascular disease

Malay diabetics below the age of 65 years had the highest O/E ratio for deaths from cerebrovascular disease (males: 2.3, females: 2.0). The corresponding ratios ranged from 0.9 to 1.7 for Chinese and 1.0 to 1.7 for Indian diabetics.

Renal failure

Younger Chinese diabetics, particularly those below the age of 65 years had a particularly high risk of dying from renal failure compared to the general population of similar age group (O/E ratio of 6.5 for males and 3.6 for females). The ratio was a more modest 1.8 and 2.0 among the Chinese diabetics aged 65 years and above. Malay male diabetics above the age of 65 years were also observed to have a high ratio of 5.0. However, the older Malay females only had a ratio of 1.0. The ratios among the younger and older Indian female diabetics were 2.0 and 3.0 respectively. The ratio for Indian male diabetics could not be calculated.

DISCUSSION

Use of death certificates

Registration of death has been the most favoured method for analysing data on diabetes mortality[1]. Reasons include the mandatory registration of all deaths in developed countries, thereby ensuring completeness of the data and the ease of accumulating large numbers of subjects. For instance, Fuller and co-workers in the United Kingdom[9], through the use of death certificates were able to analyse mortality data of over 43,000 diabetic subjects while Tokuhata and co-workers in Pennsylvania, United States[10] studied the deaths of 10,000 diabetics.

Another advantage of using death certificates is that it enables mortality trends to be studied. Sasaki and co-workers[14] performed a 20-year study of death certificates to ascertain the trend in causes of death among Japanese diabetics. Other investigators eg. Tunbridge[11] used death certificates, to identify diabetics for study. Once identified, medical records of the deceased diabetic subjects were traced to obtain more detailed information.

Most certificates of cause of death (CCOD) in Singapore are issued by doctors. A small number are issued by inspectors of the dead from the Institute of Science and Forensic Medicine, who are called by the police to examine the body when the death has not been attended to by a doctor. If death was due to unnatural causes eg. injuries and poisoning or when the cause of death is uncertain or deemed to be unnatural, the deceased will be referred to the state coroner. A post-mortem will then be concluded and the cause of death will be recorded by the pathologist. In 1991, 73.2% of total deaths were certified by medical practitioners while 22.7% were certified by pathologists/coroners. This high percentage of medical certification in Singapore increases the accuracy of causes of death certification.

Problems in the use of death certificates

The main problem surrounding the use of death certificates to study diabetes mortality is the failure of some certificates to mention diabetes at all[1,13]. Fuller and co-workers in the United Kingdom[9] traced the death certificates of a cohort of 2,134 members of the British Diabetic Association who had died over a period of 11 and 14 years. They found that only 67% of death certificates mentioned diabetes. The proportion varied with the cause of death, being highest for respiratory diseases (69%), circulatory diseases (62%) and cancer (51%) and lowest for accidents (18%). In Singapore, CCODs issued by the coroner or pathologist also commonly state only the direct cause of death.

It is thus expected that there would be mainly under-reporting of diabetes in unrelated conditions such as cancer and injuries. This is inconsequential as this study is only concerned with natural causes of death and diabetes-related conditions. With any degree of under-reporting, the impact from diabetes related deaths would be even higher than found in this study.

Diabetes as the underlying cause of death worldwide

The percentage of all deaths in which diabetes was classified as the underlying cause of death was uniformly low in most countries[7]. It ranged from 0.8% in England and Wales in 1981 to 1.0% in Japan (1984) and France (1980) to 2.0% in Australia (1983) and the United States (1982). These figures are likely to be an underestimate of the actual contribution of diabetes mellitus towards total mortality.

Underestimation of the contribution of diabetes mellitus towards total mortality

The WHO expert committee on diabetes mellitus stated in 1980[8] that analysis of diabetes mortality which was based only on the underlying cause of death would be a gross underestimate of its importance. Analysis of all conditions mentioned on death certificates may give a clearer picture of the magnitude of the contribution of diabetes towards total mortality[9].

Tokuhata and co-workers[10] reviewed 200,000 death certificates in Pennsylvania of persons who had died in 1968 – 1969 and identified some 10,000 certificates that mentioned diabetes. Of this number, only 26% recorded diabetes as underlying cause of death. Fuller and co-workers in the United Kingdom[9] worked out that the degree of underestimation of the importance of diabetes was four to five times when mortality analysis was based only on the underlying cause of death.

Causes of death in diabetics

Tokuhata and co-workers[10] in their analysis of diabetic deaths (using death certificates) in Pennsylvania in 1968 – 1969 found that the main cause of death were heart diseases (45%), followed by cerebrovascular diseases (11%). Fuller and co-workers[9] found that circulatory diseases (heart diseases, cerebrovascular disease and atherosclerosis) comprised just over 50% of causes of death in diabetics over 45 years of age.

Fuller and co-workers also compared the observed frequencies of particular underlying causes of death with expected frequencies (using general population death rates in England and Wales). The Observed/Expected (O/E) ratios for circulatory diseases were significantly greater than 1 in both sexes (ratio: 1.3). Diabetic women aged 15 – 44 years and 45 – 64 years had considerably higher ratios for ischaemic heart disease as compared to men (4.7 vs 2.8 and 2.3 vs 1.3 respectively). The O/E ratios for cerebrovascular disease were also significantly higher than 1 in both males (1.5) and females (1.3) as was the ratio for nephritis (males: 1.9 and females: 1.6).

Fuller confirmed his results by analysing the underlying causes of death in a cohort of 3,003 male and 2,968 female members of the British Diabetic Association (BDA) who were recruited between 1965 and 1969. Fuller and co-workers analysed deaths which had occurred in this cohort prior to 1980. The corresponding death certificates were also traced for the 2,134 deaths which occurred in this cohort. It was found that only 1,436 (67%) had diabetes mentioned on their death certificates.

Mortality in the BDA cohort was then compared with that of the general population of England and Wales in 1972 by calculating standardised mortality ratios (SMR) for specific causes of death. The SMRs for all causes were significantly higher than 100 (male: 153, female: 209). The SMR for ischaemic heart disease (male: 187, female: 274) and for cerebrovascular disease (male: 142; female: 142) confirmed the findings from the analysis of death certificates alone.

A paper by Sasaki and co-workers[12] gives an Asian perspective. In a dynamic cohort study, 1,221 diabetic patients (all NIDDM) first seen between 1962 and 1979, were followed-up till 1981. Causes of death were determined from death certificates as well as medical records. The mortality of the cohort of diabetic patients was compared with that of the general population in Osaka. Analysis showed that the diabetic patients experienced higher mortality for all causes (O/E ratios – males: 1.5 and females: 1.39), renal disease (O/E ratio: 11.8) and ischaemic heart disease (O/E ratio: 2.3).

The high O/E ratio for renal disease reported by Sasaki is interesting. In terms of proportion of deaths, renal disease accounted for 11.9% of all deaths among Japanese diabetics. This study found that renal failure contributed to 25% of deaths in Chinese male and female diabetics in Singapore under 65 years of age. Among male Malays and Indians of similar age-group, renal failure only accounted for 2.4% and 2.9% of deaths. The figure among female Malays and Indians were however higher at 16.7% and 10.5%. The reasons for the large ethnic differences are uncertain and there are no published studies on such ethnic differences in deaths from renal failure among diabetics.

Japan has the lowest mortality rates of ischaemic heart disease in the world[7]. This is also reflected in the Japanese diabetics studied. Only 10.4% of the 201 deaths were due to ischaemic heart disease. This is in sharp contrast to the findings of Fuller in the United Kingdom where 33.5% of deaths in the British Diabetic Association cohort were due to ischaemic heart disease[9]. Entmacher et al in the United States[13] whose studies were based on the follow-up of diabetics from the Joslin Clinic, showed that 54.5% of diabetes died from cardiac causes.

The Joslin Clinic follow-up studies of diabetics in Boston in the United States, which started in 1897, are by far the best sources on diabetes mortality data since they have been extended to recent times and therefore provide a good insight into diabetes mortality trends[1].

Entmacher et al[13] reviewed 34,499 patients from the Joslin Clinic who had died between 1897 and 1979. Between 1898 and 1922, more than 40% of deaths were ascribed to diabetic coma while only 20% were due to vascular causes (cardiac, renal, cerebral and peripheral causes). With the discovery of insulin, the proportion of deaths due to diabetic coma fell to 4.5% in the 1922 – 1949 period while vascular causes rose to more than 60% of deaths. Between 1965 – 1979, the percentage of deaths due to diabetic coma was just 1.2%.

In comparison, deaths from diabetic ketoacidosis and hyperosmolar non-ketotic coma among diabetics in this study amounted to 1.6% among male diabetics and 2.0% among female diabetics. A higher percentage of deaths (male: 5.3% and female: 5.7%) from these causes was found in the youngest age group (< 55 years). This may be due to more insulin-dependent diabetics in this group as compared to the other age groups.

Another interesting finding was the finding that amongst those aged < 65 years, deaths from DKA/HHNK occurred in 4.9% and 5.9% in Malay and Indian males respectively, and 4.2% in Malay females, whereas none was reported in Chinese. It

may be postulated that the higher figures amongst Malays and Indians reflect a poorer degree of diabetes control, or that these patients had sought treatment relatively late, both known risk factors for poor outcome for DKA/HHNK.

Between 1950 and 1979, 75% of 16,740 diabetic deaths from the Joslin Clinic could be attributed to vascular complications (ie. cardiac, cerebrovascular, renal and gangrene). Two-thirds of these deaths were cardiac in origin (54.5% of all diabetic deaths). The death rate from cardiovascular diseases was 2 to 3 times higher than in the general population of Massachusetts in the United States. A similarly high proportion of deaths from vascular complications was found in this study where 58.6% of male deaths and 60.8% of female deaths were attributable to such causes. Of these deaths from vascular causes, slightly more than half were cardiac in origin.

CONCLUSION

Diabetes mellitus as a cause of death in Singapore is grossly underestimated by current methods of classifying the underlying cause of death. If all diabetes-related deaths were considered, the contribution of diabetes towards total mortality in Singapore in 1991 would rise from 2.3% of all deaths in the official mortality statistics to 9.3%.

The contribution of chronic conditions like diabetes towards mortality could be better studied if multiple cause of death coding was practised. Presently in Singapore, only the single underlying cause of death is coded and used for the reporting of national mortality statistics. Other causes of death mentioned on the death certificate are merely recorded in text format for administrative purposes.

The findings in this preliminary study of mortality among diabetics in Singapore should be confirmed by a follow-up study among a known cohort of diabetics.

REFERENCES

1. Ekoe JM. Chapter 15: Epidemiology of the long term complications of the diabetes mellitus syndrome. Chapter 16: Diabetes Mortality. In: Diabetes Mellitus, Aspects of the world-wide epidemiology of diabetes mellitus and its long term complications. Elsevier, Amsterdam, New York, Oxford, 1988:181-235.
2. Report on registration of births and deaths, 1991. Registry of Births and Deaths, National Registration Department, Singapore.
3. Manual of the International Statistical Classification of Diseases, Injuries and Causes of Death. Ninth Revision,1975. World Health Organisation, Geneva.
4. Cheah JS. et al. Diabetes mellitus in Singapore, results of a country-wide population survey. In: Cheah JS (ed) Proceedings of the 6th Asian and Oceania Congress of Endocrinology, 1978:227-38.
5. Thai AC, et al. Diabetes mellitus and its chronic complications in Singapore: An increasing healthcare problem. Ann Acad Med Singapore 1990; 19(4):517-23.
6. The Health of Singaporeans, 1993. Ministry of Health, Singapore.
7. World Health Statistics Annual 1978-1985, Vital statistics and causes of death, World Health Organisation, Geneva.
8. WHO: Footnote to Annex 3. In: WHO Expert Committee on Diabetes Mellitus, 2nd Report. Technical Report Series #646. WHO, 1980:73.
9. Fuller JH, Elford J, Goldblatt P, Adelstein AM. Diabetes Mellitus: New light on an underestimated public health problem. Diabetologia 1983; 24:336-41.
10. Tokuhata GK, Miller W, Digon E, Hartman T. Diabetes Mellitus: An underestimated public health problem. J Chron Dis 1975; 28:23-35.
11. Tunbridge WMG. Factors contributing to deaths of diabetics under fifty years of age. Lancet 1981; 2:569-72.
12. Sasaki A, Horiuchi N, Hasagawa K, Uehara M. A long term follow-up study of Japanese diabetic patients: Mortality and causes of death. Diabetologia 1983; 25: 309-12.
13. Entmacher PS, Krall LP, Kranczer SN. Diabetes mortality from vital statistics. In: Marble A, Krall LP, Bradley RF, Christlieb AR, Soeldner JS (eds), Joslin's Diabetes Mellitus, 12th edition, Philadelphia, Lea and Febiger: 1985:278-97.
14. Sasaki A, Horiuchi N, Hasagawa K, Uehara M. Causes of death in Japanese diabetics. A 20-year study of death certificates. J Chron Dis 1985; 38(8):655-61.