Turkish Journal of Endocrinology and Metabolism, (1998) 4 : 231-238 **ORIGINAL ARTICLE**

Premature Mortality and Years of Potential Life Lost Due to Diabetes Mellitus

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The aim of the study is to compute, Years of Potential Life Lost attributed to diabetes mellitus, as a measure of premature mortality.

In 1994, the total 1993 year deaths of Bornova Education and Research District were determined by screening the death certificates of the cemetery directorate. Of the total 795 death certificates, the underlying cause of mortality of 390 deaths were identified by using verbal autopsy technique.

Diabetes deaths represented 19.7 % of the total deaths and 12.1 % of the total YPLL. The mean age of death is higher in diabetic women (74.8) than diabetic men (65.4) ($p<0.05$) The mean YPLL is significantly higher in males (13.9 years) than females (10.4 years) in the deaths with diabetes as either an underlying or contributing cause ($p<0.05$). The mean YPLL of the non-diabetic deaths are significantly higher than of diabetic deaths ($p<0.05$). But in the 65 and over age group, the mean YPLL of the diabetic and non-diabetic deaths do not differ.

It seems that, diabetes mellitus entails quite high YPLL especially in the 65 and over age group. On the other hand, male diabetics are obviously a high risk group for premature mortality and their associating risk factors should be monitored and eliminated. Population-wide diabetes control programs must be carried out as soon as possible in Turkey.

KEY WORDS Diabetes mellitus, mortality, indirect costs

Introduction

Diabetes Mellitus is one of the leading causes of morbidity and mortality in the developed countries (1,2). Rapid urbanisation and increased migration trends to metropolitan areas are expected to increase the prevalence of diabetes by changing the life styles and living habits of people in the developing countries. Diabetes is probably a major factor in the economic costs of living for individuals with diabetes (2). The health care expenditures attributed to diabetes were estimated to be 20-25 million US dollars in the developed countries (3). Diabetes was the fourth most important cost generating cause among all diseases in Sweden (4). Per capita health expenditures in the USA were two to three fold greater for diabetics than non-diabetic patients (5). Diabetes Mellitus is the seventh leading cause of mortality and the fourth most fatal disease in the United States (1). Diabetes Mellitus was the 14th leading cause of mortality in Turkey in 1993 (2). In New Zealand, cause specific mortality rate of diabetes mellitus was 19 for the 25-44 age group, and 79 for the 45-64 age group per hundred thousand (3).

Mortality is the most important figure for demonstrating the effect of diabetes and its international standardisation. Although this is the case, the lack of reporting diabetes as an underlying cause of mortality is a common problem for all countries (4). Even in the US and UK, only 25% of the deaths of which the underlying cause was diabetes mellitus were reported in the death certificates (5). The American Diabetes Association has reported that

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diabetes deaths either as an underlying or contributory cause are reported on fewer than half of the death certificates in the US (1). Another study has shown that, of the expected 434 thousand deaths, only 188 thousand were reported as diabetes mellitus as the contributing cause in 1992 in the US (6).

The national economy loses 7.5 billion US Dollars annually due to premature deaths attributed to diabetes mellitus alone in the US. In the developed countries annual potential life years lost attributed to diabetes is 1000-7000 per million population (7). Indirect costs due to diabetes deaths form one third of the total costs and two-thirds of the indirect costs (6,8).

In calculating the indirect mortality costs of diabetes, productive and/or non-productive life years lost are taken into account. If you are calculating only the life years lost, it is not important whether the persons are in the productive age group or not. The researcher must have access to the mortality data and the additional expected life years for every age group in this calculation. (10,11). Unemployment is a great restriction in calculating the production (12).

The aim of this study is to describe the demographic characteristics of the diabetic and non-diabetic deaths and to calculate the Years of Potential Life Lost due to the deaths of which the underlying and contributing causes are diabetes mellitus or causes other than diabetes mellitus.

Material and Methods

This is a descriptive design study based on the death certificates and verbal autopsy findings. The study was carried out in the second half of the year 1994.

795 deaths in 1993 occurring in the Bornova Education and Research District constituted the study population. The mid-year population of the Bornova (ERD) in 1993 was 142 285 and the Crude Death Rate was 5.59 %.

Izmir Municipality Cementery Directorate death records were merged with the Bornova Education and Research District death certificates in order to identify the number and the addresses of the total deaths in the district. Then every address printed on the death certificates was visited and a specific administered questionnaire was applied to the relatives of the dead persons to identify the cause of death. The visits were repeated when no one was found at the address. The questionnaire was composed of 15 open ended items exploring the cause of death in a systematic approach and administered by intern doctors. This process is called verbal autopsy.

Of the 795 deaths, 596 (75.0 %) of their relatives were able to be found at the given address. 25 % of the relatives had moved or the addres was wrong. 77.7 % (463/596) of the relatives responded to the questionnaire. And overall causes of mortality of 390 of the 463 deaths were able to be identified by verbal autopsy.

After that, the expected additional life years of every death were computed. The State Institute of Statistics' figures (13) for the expected additional life years per age group in Turkey were used to calculate additional expected life years per age. This was done by a statistical method known as linear extrapolation.

The formula of linear extrapolation is as follows: (9)

$$\frac{e^{1} - e^{2}}{e^{3} - e^{2}} = \frac{e^{1x} - e^{2x}}{e^{3x} - e^{2x}}$$

e^{1} = The target age

e^{2} = The first age of the age group of the target age.

e^{3} = The last age of the age group of the target age

e^{1x} = Expected additional life years of the target age (to be calculated)

e^{2x} = Expected additional life years of the first age of the age group of the target age

e^{3x} = Expected additional life years of the last age of the age group of the target age

Some brief explanation about the deaths mentioned in this study can be given as:

All deaths (n=795):All deaths registered in 1993 in the district.

Cause identified deaths (n=390): The deaths in which the cause of death could be identified.

Diabetic deaths (n=77): The deaths with diabetes mellitus as any cause (underlying or contributory) of death.

Diabetic death as underlying condition: Acute complications of diabetes mellitus.

Diabetic death as contributory condition: Chronic complications of diabetes mellitus or diabetes as a co-morbid condition.

The cause of death could not be identified clearly in where diabetes mellitus was the underlying condition or the cause of death was a chronic complication of diabetes mellitus. So diabetic deaths are classified into two groups: 1- diabetes as the underlying cause, or chronic complications of diabetes and 2- diabetes mellitus as a co-morbid condition.

The data were processed by Epi Info version 5.01 software package.

Results

The mean age of all deaths; cause identified deaths; diabetic deaths and non-diabetic deaths are presented in Table 1. Only diabetic deaths show significant sex differences in the mean age of death. In diabetic deaths the mean age of death is higher in females than males (p=0.001). The mean age of death in both sexes and in total are significantly higher in cause identified deaths than total registered deaths (p<0.05). The mean age of death in diabetics is significantly higher than non-diabetic persons in both sexes (p<0.05). And females show significantly higher mean age of death than males in diabetic deaths (p=0.001). In the non-diabetic deaths males and females do not differ in the mean age of death (p=0.61).

As shown in Table 2, the total potential life years lost (YPLL) attributed to cause identified (390) deaths is 7931 years. The mean YPLL is 20.3 years for the total deaths. Male deaths show significantly higher YPLL than female deaths in the 65 and over group (p=0.019), while the opposite is true in the 45-64 age group (p= 0.036).

In 19.7 % of the total deaths (77/390) diabetes mellitus was identified as any cause of death. 12.1 % (961/7931) of the total YPLL is attributed to diabetic deaths. The mean YPLL is 12.5 years for all diabetics, while it is 13.9 years for males and 10.4 years for females. The mean YPLL is significantly higher in males than females in the deaths with diabetes as either underlying or contributing cause (p<0.05) (Table 3 and 4). On the other hand if diabetes mellitus is a co-morbid condition, the mean YPLL does not differ between the two sexes (p=0786) (Table 5). As in the cause identified

Table 1. Comparison of the mean age of death in registered, cause identified, diabetic and non-diabetic deaths (1993).

	Registered (all) deaths n = 795		Cause identified deaths n = 390			
	Years	Sd	Years	Sd		
Male	53.8	24.56	57.9	24.06	t = 10.80	p = 0.001
Female	55.5	27.77	62.1	28.99	t = 14.35	p = 0.000
Total	54.5	25.99	59.6	26.26	t = 10.02	p = 0.003
	t = 0.74 p = 0.38		t = 1.54 p = 0.12			
	Diabetic deaths n = 77		Non-diabetic deaths n=313			
	Years	Sd	Years	Sd		
Male	65.4	11.62	56.1	25.95	t = 2.34	p = 0.019
Female	74.8	44.73	58.9	31.08	t = 2.82	p = 0.006
Total	69.3	12.37	57.3	28.18	t = 13.31	p = 0.000
	t = 3.51 p = 0.001		t = 0.88 p= 0.61			

Table 2. The distribution of the Years of Potential Life Lost (YPLL) of the deaths of Bornova district, according to the age groups and gender(1993).

Age Group	Gender			YPLL[a]		Mean YPLL		Comparison of the means[b]
		n	%	years	%	years	Sd	
0 - 44	Male	43	55.1	2193	53.1	51.0	14.20	t = 1.294
	Female	35	4.9	1935	46.9	55.3	15.02	p = 0.196
	Total	78	20.0	4128	52.0	52.9	14.63	
45 - 64	Male	88	72.1	1614	70.3	18.3	15.61	t = 2.089
	Female	34	27.9	683	29.7	20.1	.53	p = 0.036
	Total	122	31.3	2297	29.0	18.8	4.18	
65 +	Male	97	51.1	809	53.7	8.3	7.15	t = 2.337
	Female	93	48.9	697	46.3	7.5	2.30	p = 0.019
	Total	190	8.7	1506	19.0	7.9	2.53	
All ages	Male	228	58.5	4616	58.2	20.2	16.95	t = 0.114
	Female	162	41.5	3315	41.8	20.5	20.39	p = 0.905
	Total	390	84.2	7931	100.0	20.3	18.43	

Percentages are column percentages. n = 390

[a] YPLL = Years of Potential Life Lost

[b] Comparison of the mean YPLL's of males and females

Table 3. The distribution of the Years of Potential Life Lost (YPLL) of the deaths in which diabetes aws either an underlying or contributory condition (Diabetes as any cause of death) (1993).

Age Group	Gender		YPLL[a]		Mean YPLL		Comparison of the means[b]
		n	years	%[c]	years	Sd	
0 - 44	Male	1	33	51.6	33.4	-	
	Female	1	30	48.4	30.3	-	
	Total	2	64	6.6	31.8	2.23	
45 - 64	Male	25	438	80.5	17.5	3.91	t = 0.120
	Female	6	106	19.5	17.7	1.60	p = 0.901
	Total	31	544	56.6	17.6	3.56	
65 +	Male	19	156	44.2	8.2	2.58	t = 0.388
	Female	25	197	55.8	7.9	2.44	p = 0.702
	Total	44	353	36.8	8.0	2.48	
All ages	Male	45	627	65.2	13.9	6.42	t = 2.456
	Female	32	334	34.8	10.4	5.76	p = 0.016
	Total	77	961	100.0	12.5	6.36	

Percentages are column percentages. n=77

[a] YPLL = Years of Potential Life Lost

[b] Comparison of the mean YPLL's of males and females

[c] Column percentage

deaths, in the non-diabetic deaths, male deaths show significantly higher YPLL than female deaths in the 65 and over age group (p=0.046), while the opposite is true in the 45-64 age group (p= 0.013) (Table 6).

Table 4. The distribution of the Years of Potential Life Lost (YPLL) of the deaths in which diabetes was an underlying condition or the cause of death was a chronic complication of diabetes (1993).

Age Group	Gender	YPLL[a]			Mean YPLL		Comparison of the means[b]
		n	years	%[c]	years	Sd	
0 - 44	Male	1	33	-	33.4	-	
	Female	-	-		-	-	
	Total	1	33	4.5	33.4	-	
45 - 64	Male	20	334	79.3	16.7	3.42	t = .502
	Female	5	87	20.7	17.4	1.62	p = 0.626
	Total	25	421	57.4	16.8	2.97	
65 +	Male	13	98	35.0	7.5	2.29	t = 0.509
	Female	23	183	65.0	7.9	2.52	p = 0.620
	Total	36	280	38.1	7.8	2.42	
All ages	Male	34	464	63.2	13.7	6.34	t = 2. 840
	Female	28	270	39.8	9.6	4.39	p = 0.006
	Total	62	734	100.0	11.9	5.86	

Percentages are column percentages. n=62

[a] YPLL = Years of Potential Life Lost

[b] Comparison of the mean YPLL's of males and females

[c] Column percentage

Table 5. The distribution of the Years of Potential Life Lost (YPLL) of the deaths in which diabetes is a co-morbid condition (1993).

Age Group	Gender	YPLL[a]			Mean YPLL		Comparison of the means[b]
		n	years	%[c]	years	Sd	
0 - 44	Male	-	-	-	-	-	
	Female	1	30	100.0	30.3	-	
	Total	1	30	13.2	30.3	-	
45 - 64	Male	5	104	84.6	20.9	4.93	
	Female	1	19	15.4	19.1	-	
	Total	6	123	54.5	20.6	4.64	
65 +	Male	6	58	79.5	9.7	2.76	
	Female	2	15	20.5	7.4	1.57	
	Total	8	73	32.3	9.1	2.63	
All ages	Male	11	162	71.7	14.8	6.91	t = 0.271
	Female	4	64	28.3	16.0	11.02	p = 0.786
	Total	15	226	100.0	15.1	7.80	

Percentages are column percentages. n=15

[a] YPLL = Years of Potential Life Lost

[b] Comparison of the mean YPLL's of males and females

[c] Column percentage

In the whole age groups and 45-64 age group, the mean YPLL of the non-diabetic deaths are significantly higher than of diabetic deaths ($p<0.05$). But in the 65 and over age group, the mean YPLL of the diabetic and non-diabetic deaths do not differ (Table 7).

Table 6. The distribution of the Years of Potential Life Lost (YPLL) of the non-diabetic deaths (1993).

Age Group	Gender	YPLL[a]			Mean YPLL		Comparison of the means[b]
		n	years	%[c]	years	Sd	
0 - 44	Male	42	2159	53.1	51.4	14.10	t = 1.395
	Female	34	1905	46.9	56.0	1.59	p = 0.163
	Total	76	4064	58.2	53.5	14.41	
45 - 64	Male	63	1176	67.1	18.7	3.95	t = 1.995
	Female	28	577	32.9	20.6	4.81	p = 0.046
	Total	91	1753	25.2	19.3	4.30	
65 +	Male	78	653	56.6	8.4	2.71	t = 2.483
	Female	68	500	43.4	7.4	2.24	p = 0.0135
	Total	146	1153	16.6	7.9	2.55	
All ages	Male	183	3989	57.2	21.8	18.36	t = 0.495
	Female	130	2981	42.8	22.9	21.90	p = 0.613
	Total	313	6970	100.0	22.3	19.87	

Percentages are column percentages. n=313

[a] YPLL = Years of Potential Life Lost

[b] Comparison of the mean YPLL's of males and females

[c] Column percentage

Table 7. Comparison of the mean YPLL of diabetic deaths with that of non-diabetic deaths (1993).

Age Group	Gender	Diabetic deaths n = 77		Non-diabetic deaths n = 313		Comparison of the means	
		Mean YPLL		Mean YPLL			
		years	Sd	years	Sd		
0 - 44	Male	33.4	-	51.4	14.10		
	Female	30.3	-	56.0	1.59		
	Total	31.8	2.23	53.5	14.41		
45 - 64	Male	17.5	3.91	18.7	3.95	t =1.243	p = 0.215
	Female	17.7	1.60	20.6	4.81	t =1.433	p = 0.158
	Total	17.6	3.56	19.3	4.30	t =1.992	p = 0.046
65 +	Male	8.2	2.58	8.4	2.71	t = 0.269	p = 0.785
	Female	7.9	2.44	7.4	2.24	t = 1.026	p = 0.308
	Total	8.0	2.48	7.9	2.55	t = 0.293	p = 0.768
All ages	Male	13.9	6.42	21.8	18.36	t = 2.832	p=0.005
	Female	10.4	5.76	22.9	21.90	t = 3.192	p = 0.002
	Total	12.5	6.36	22.3	19.87	t = 4.267	

[a] YPLL = Years of Potential Life Lost

[b] Comparison of the mean YPLL's of males and females

Discussion

The results were derived from 49 % (390 / 795) of the total deaths in the district. The crude mortality rate (5.59 %) of the district was in agreement with the State Institute of Statistics data (2). Cause identified deaths show a statistically higher mean age of death than total registered deaths. In other words, we can say that the cause of younger age deaths could not be determined as easily as older age deaths. This might be due to the unwillingness of their relatives to remember them.

The results of this study have shown that the overall mortality rate of diabetes mellitus was 101.2 per 100.000 when all listed causes of death are considered. This was 64.0 in 1993 in USA (1). Though the crude mortality rate of Bornova district was smaller than USA (0.8 %) our figure seems to overestimate. But on the other hand, the distribution of the deaths of 45 and over age groups of cause identified deaths is similar to the distribution of all deaths. So the high mortality rate found in this study can not be attributed solely to the poor representativeness of the cause identified deaths.

While the mean age of death is no different between males and females in the non-diabetic deaths, female deaths show a significantly higher mean age of death than males in diabetic deaths. The same conclusion can be made if we look at the higher mean YPLL in men than women, in the deaths where either diabetes is an underlying condition or the cause of death is a chronic complication of diabetes. Also the insignificant difference between the mean YPLL of men and women in the deaths in which diabetes is a co-morbid condition supports this finding. This can be interpreted that, in the complicated diabetics, men die earlier than women probably because of some associating risk factors such as smoking and atherosclerosis which are more prevalent in males than females.

The total YPLL for the total 390 deaths is found as 7931 years. We can make a very crude approximation that: if we could obtain data for the total 795 deaths this would be 16 167 years and in 1993 6.5 million YPLL would be expected for Turkey.

In this study only the mortality component of indirect cost of diabetes mellitus could be calculated because of the lack of data demonstrating the mean per capita earnings of the population in Turkey; the high unemployment rate and the high inflation rate of the country. These findings on the other hand, may be helpful in demonstrating the lack of national data on the prevalence and the demographic aspects of diabetes mellitus and the other chronical diseases in Turkey.

On the other hand, the notification of diabetes mellitus as an underlying cause in the death certificates has been shown to be underestimated in other countries (4). Even in the USA and UK, only 25 -50 % of diabetic deaths were detected to be reported in death certificates as an underlying cause of mortality (1,5,15,16,17,18,19). In Croatia, a new diabetes control programme held in the years 1970-1985 has improved the notification of diabetes as an underlying cause of mortality from 7.7 to 12.1 for per 100 000 living diabetics. This approximately 40 % increase was interpreted to be due to the taking of great pains with filling in the death certificates (7). It has been shown that there are significant differences among physicians in filling in the death certificates. The results of EURODIAB C Region have shown this difference which was 21% in France and 35% in Germany (20).

The fatality rates were found as 2.3 % for all ages; 4.5 % for males aged 65 and over; 10.5 % for females aged 65 and over. In the USA the fatality rate was found as 6.6 % for the total diabetic deaths while it was 12% for the 65 and over age group (19). In fatality rates calculations the prevalence figures of Uçku's study performed in Narlıdere district, Izmir were used (14).

Male diabetics are obviously a high risk group for premature mortality and their associating risk factors should be monitored and eliminated. The economic and social burden of diabetes mellitus can be expected to get worse when we take high urbanization trends and life style changes into account. This situation stresses the need for applying a comprehensive diabetes control programme covering the whole population whenever possible in Turkey.

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