Trends in Diabetes Mellitus Mortality in Puerto Rico: 1980-1997

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Objective. **To determine the characteristics and trends of diabetes mortality among the Puerto Rican population from 1980 through 1997.**

Methods. **Death certificates for Puerto Rican residents whose underlying cause of death was diabetes mellitus (ICD-9-250.0) were reviewed, and sociodemographic information was abstracted. The proportion mortality ratio (PMR) and 95% confidence intervals were calculated by gender, age group, educational level and period of time. Trend analysis in mortality was performed using a Poisson regression model.**

Results. **A total of 26,193 deaths (5.8%) were primarily attributed to diabetes mellitus in the study period. Females accounted for 55.8% of all diabetes related deaths. Diabetes accounted for a higher proportion of deaths among persons aged 60-64 years (8.14%), persons aged 65-74 (8.12%), females (7.73%) and those with 1-6 years of education (7.08%). The PMR steadily increased from 4.55% in the 1980-85 period to 6.91% in the 1992-97 period. There was a higher mortality in male diabetic subjects aged ≤ 64 than in females during the 18 year period. Between 1980 and 1991, females aged 65-74 had a higher mortality than males, however, mortality increased in males of the same age group during 1992-97. When the oldest age group (≥ 75) was examined, males had a higher mortality between 1986 and 1997, whereas females had a slightly higher rate between 1980 and 1985.**

Conclusions. **Our results indicate that diabetes mortality has been markedly increasing in the Puerto Rican population, primarily in persons aged 65 years or more. Further analysis is needed to evaluate the determinants of mortality in diabetes.**

Key words: Diabetes mellitus, Mortality, Puerto Rico, Trends

Diabetes mellitus (DM) remains the third leading cause of mortality in Puerto Rico (1). Indeed, in other countries of the Caribbean such as Jamaica, Bahamas, Barbados, and Dominica, it is also one of the main causes of mortality (2). DM mortality is known to be higher in Hispanics residing in the United States compared with non-Hispanics (3-4). Prevalence of type 1 and type 2 DM in the Americas shows a wide intra-regional variation. However, the prevalence in the Caribbean area is considered high (2).

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This study was supported by the Office of the Dean for Academic Affairs, Medical Sciences Campus, University of Puerto Rico.

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DM registries in geographically defined populations have provided an epidemiological basis for longitudinal investigations of complications and mortality patterns of the disease. Although it is well known that the disease is substantially under-reported in the death certificates, the majority of the American countries consider death certificates as the most important source of DM data in the absence of registries or costly longitudinal studies (5-8).

DM is acknowledged to be an increasing public health problem in the Puerto Rican population. However, morbidity and mortality trends in diabetic subjects have not been addressed. Therefore, the aim of this study was to describe the characteristics and trends of DM mortality among the Puerto Rican population from 1980 through 1997.

Methods

The Puerto Rico Demographic Registry, under the jurisdiction of the Puerto Rico Health Department, is the repository of all death certificates in the island. The death certificates contain sociodemographic information as well

as immediate, underlying and other significant conditions contributing to death. Death certificates of all persons who died in Puerto Rico between January 1, 1980 and December 31, 1997 were reviewed. Records that mentioned DM (ICD-9-250.0) as an underlying cause of death were selected as being a diabetic case. Demographic data on the Puerto Rican population were obtained from the Census and Vital Statistics.

There were 26,193 persons whose primary cause of death was DM during the study period. The number of deaths from DM was analyzed by sociodemographic variables such as age, sex, marital status, education, municipality of death, occupation, and year of fatal event.

To detect the number of persons with DM listed only as a contributory cause in the death certificates, all deaths occurring in 1997 were reviewed. This year was selected because it was the first year that the Puerto Rico Demographic Registry included the contributory causes of death in the computerized system files. A total of 1,205 death certificates were identified by the Demographic Registry personnel as having DM as a contributory cause. We obtained copies of 1,042 (86.5%) death certificates that were available at the time of request. Of these, 906 (86.9%) had DM listed as a contributory cause only. The remaining 136 (13.1%) had DM as the underlying as well as the contributory cause of death. These cases (n=136) were included in the 26,193 persons whose primary cause of death was DM. Therefore, these 136 cases were not included in the group of deaths that had diabetes as the contributory cause.

Proportional mortality ratio (PMR) relative to all causes of death and its 95% confidence interval (CI) were calculated by sex, age group, educational level and period of death using the following formula:

$$\frac{\text{Number of deaths from DM in Puerto Rico during 1980-1997}}{\text{Total deaths in Puerto Rico during 1980-1997}} \times 100$$

A Poisson regression model was used to evaluate the trends in DM mortality by sex and age using the statistical package GLIM4 (9-10). The annual mortality rate was calculated by time periods (1980-85, 1986-91, 1992-97) using the following expression:

$$\frac{\text{Number of deaths attributed to DM during the study period}}{\text{Sum of mid-year populations during the study period}} \times 100{,}000$$

Relative risk (RR) and its 95% CI were used to compare DM mortality rates by time period within age categories (≤ 64, 65-74, ≥ 75) for males and females, respectively.

Results

The vast majority (74.6%) of diabetes deaths occurred among persons aged 65 years and older (Table 1). More than half of the cases (55.8%) were females and 64% had six years or less of education. Nearly 46% of the deaths attributed to diabetes were reported between 1992 and 1997. The number of deaths varied greatly between health regions, with the metropolitan region having the highest

Table 1. Characteristics of DM Mortality, Puerto Rico, 1980-1997 (n=26,193)

	Diabetes mellitus	
	Number of Deaths	**Percentage**
Age group (years)		
≤ 19	34	0.1
20-24	44	0.2
25-29	76	0.3
30-34	108	0.4
35-39	197	0.7
40-44	322	1.2
45-49	609	2.3
50-54	1,066	4.1
55-59	1,635	6.2
60-64	2,582	9.9
65-74	7,298	27.9
75-84	8,109	31.0
≥ 85	4,103	15.7
Unspecilied	10	0.04
Sex		
Male	11,573	44.2
Female	14,620	55.8
Educational level (years)		
None	3,794	14.5
1-6	12,958	49.5
7-9	3,658	14.0
10-11	419	1.6
12+	5,341	20.4
Unspecified	23	0.1
Time period		
1980-85	5,986	22.5
1986-91	8,313	31.7
1992-97	11,984	45.8

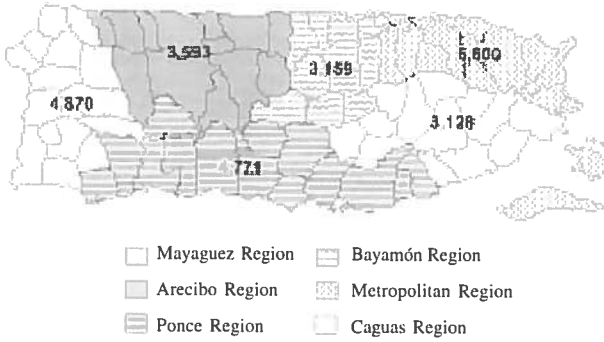


Figure 1. Geographic distribution of DM mortality by Health Region, Puerto Rico, 1980-1997

Table 2. DM Proportional Mortality Ratio (PMR), Puerto Rico, 1980-1997

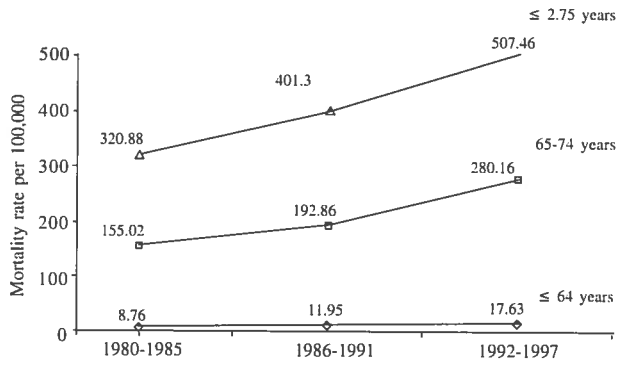
Characteristics	Number of DM related deaths	Total number of deaths	PMR (%)	95% CI
Age group (years)				
≤ 19	34	26,879	0.13	0.09-0.18
20-24	44	7,342	0.60	0.44-0.81
25-29	76	8,868	0.86	0.68-1.08
30-34	108	11,084	0.97	0.80-1.18
35-39	197	12,694	1.55	1.35-1.79
40-44	322	13,733	2.34	2.10-2.61
45-49	609	15,250	4.99	3.69-4.32
50-54	1,066	18,363	5.80	5.47-6.15
55-59	1,635	22,923	7.13	6.80-7.47
60-64	2,582	31,729	8.14	7.84-8.44
65-74	7,298	89,874	8.12	7.94-8.30
75-84	8,109	108,380	7.48	7.32-7.64
≥ 85	4,103	85,820	4.78	4.64-4.93
Unspecified	10	1,211	0.83	0.42-1.57
Sex				
Male	11,573	265,064	4.37	4.29-4.44
Female	14,620	189,053	7.73	7.61-7.85
Educational level (years)				
None	3,794	83,597	4.54	4.40-4.68
1-6	12,958	182,986	7.08	6.96-7.20
7-9	3,658	62,009	5.90	5.72-6.09
10-11	419	10,706	3.91	3.55-4.30
12+	5,341	114,393	4.67	4.55-4.79
Unspecified	23	462	4.98	3.18-7.38
Time period				
1980-1985	5,896	129,691	4.55	4.43-4.66
1986-1991	8,313	150,927	5.51	5.39-5.62
1992-1997	11,984	173,535	6.91	6.79-7.03

number of diabetes related deaths (Figure 1). Death certificates which listed DM as a contributory cause of death in 1997 were 906, of which, 55.5% were females (data not shown). This figure represented 30.2% of diabetics that were not considered in the calculated mortality rate. If these cases were added to the mortality rate calculation for that year (1997), the mortality rate would have increased from 55.9 per 100,000 population to 80.1 per 100,000 population. However, not all diabetics died from DM related causes (data not shown).

Table 2 shows the PMR and 95% confidence limits by study characteristics. Diabetes accounted for a higher proportion of deaths among persons aged 60-64 years (8.14%), persons aged 65-74 (8.12%), females (7.73%) and those with 1-6 years of education (7.08%). The PMR steadily increased from 4.55% in the 1980-85 period to 6.91% in the 1992-97 period.

The results of the trend analysis using a Poisson regression model showed significant interaction between the study variables. The statistically significant interaction terms were the following: age*sex ($p<0.0001$), age*period ($p<0.0001$) and sex*period ($p<0.0001$). Interaction refers to differences in the effects of one or more factors according to the level of the remaining factors (11). For example, an age *sex interaction implies that the mortality rate by age group varies by sex. Therefore, the trends in the mortality rates were analyzed by comparing two time periods by age categories in males and females, respectively.

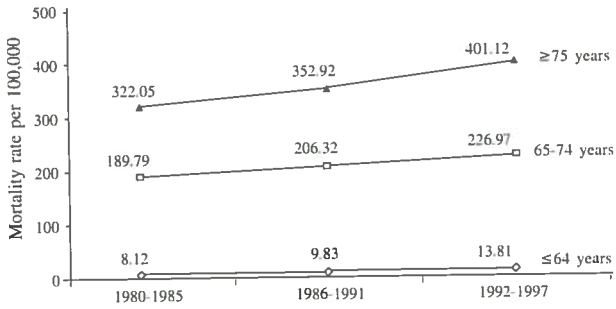
There was a higher mortality rate in male diabetic



Estimation of Relative Risk between Periods by Age Group

Age Group (years)	Study Periods: 1986-91 vs. 1980-85	Study Periods: 1992-97 vs. 1986-91
≤ 64	1.36 (95% CI: 1.28-1.45)	1.48 (95% CI: 1.41-1.55)
65-74	1.24 (95% CI: 1.17-1.32)	1.45 (95% CI: 1.38-1.52)
≥75	1.25 (95% CI: 1.19-1.32)	1.26 (95% CI: 1.21-1.32)

Figure 2. Annual mortality rates of DM among males by age group and period of death, Puerto Rico, 1980-1997



Estimation of Relative Risk between Periods by Age Group

Age Group (years)	Study Periods: 1986-91 vs. 1980-85	1992-97 vs. 1986-91
≤ 64	1.21 (95% CI: 1.13-1.29)	1.40 (95% CI: 1.33-1.48)
65-74	1.09 (95% CI: 1.03-1.15)	1.10 (95% CI: 1.05-1.16)
≥ 75	1.15 (95% CI: 1.10-1.19)	1.14 (95% CI: 1.11-1.18)

Figure 3. Annual mortality rates of DM among females by age group and period of death, Puerto Rico, 1980-1997.

subjects aged ≤ 64 years than in females during the 18 year- period (See Figures 2 and 3). Between 1980 and 1991, females aged 65-74 had a higher mortality rate than males, however, mortality increased in males of the same age group during 1992-97. When the oldest age group (≥ 75) was examined, males had a higher mortality rate between 1986 and 1997, whereas females had a slightly higher rate between 1980 and 1985.

Discussion

Our results indicate that the mortality rate attributed to DM has been markedly increasing in the Puerto Rican population. DM mortality occurred primarily in persons aged 65 years or more, a pattern similar to that observed in other chronic diseases. This increasing tendency in DM mortality remained after adjusting for age, and it may be a reflection of an increase in the prevalence or a sub-optimal care of DM patients in Puerto Rico.

It is well known that people with DM in developed countries have a reduced life expectancy with age-specific mortality rates twice that of the non-diabetic population. This rate varies among populations and tends to diminish with increasing age at onset of DM. Indeed, the contribution of DM mortality using only death certificates listed as underlying causes of deaths is known to be underestimated (12-13).

Among all causes of death reported during the study period, diabetes accounted for a higher proportion of deaths among females than males. However, the mortality rate from diabetes in the general population showed that males had a higher risk of dying from diabetes in the older age groups than females in all time periods, while females had a higher probability of dying of diabetes in the 65 to 74 age group in the earlier period of time. The excess mortality of DM between sexes has not been consistent. Some studies have demonstrated that diabetic women have a mortality rate higher than males in some age groups (14-19), while others have shown excess mortality among males. This has been attributed to the advantageous longevity experienced by females compared with males. Others have reported similar mortality rates for persons aged 65 to 74, but the mortality increases more rapidly in women than in men above that age range. Although possible explanations are unknown, it has been postulated that the larger percentage of body fat in women may be a contributing factor (14). However, in the entire American region, DM mortality is reported higher in females (1.33:1 in North America and 1.2:1 in Latin America) unadjusted by age (19). These higher rates have been attributed to several factors including a higher probability of developing type 2 diabetes and a longer life expectancy leading to a higher probability of developing the disease in some stage of life. It remains unknown if health access or quality of diabetes care differs by sex (20). Similar to the findings of this study, low educational status has been found to be a risk factor for mortality among diabetic patients (21).

In Puerto Rico, life expectancy is 70 years for males and 79 for females. The favorable status of life expectancy among women in the Puerto Rican population emphazises the greater impact of DM as a mortality risk in older males compared with females. It has been reported that the reduction in life expectancy from diagnosis in middle-aged patients with type 2 diabetes is 5 to 10 years on average (22-25). In Puerto Rico, life expectancy for females seems to be reduced by several years. The life table for females in Puerto Rico (all causes of deaths, 1995-1997) demonstrated that the average number of years of life remaining at the beginning of the 65 to 70 age interval is 18.84 (26).

Prevention of complications among diabetic patients will likely have a substantial impact in decreasing mortality. Thus, large scale screening of DM complications such as microalbuminuria are needed to provide an early identification of these complications in Puerto Rico. Further population-based longitudinal studies of well-defined patient groups are needed to evaluate the determinants of mortality in diabetes.

The trends in DM mortality using death certificates reported in this study provided an analysis of a Hispanic population. The main disadvantage of this type of approach is the sub-estimation of mortality directly or indirectly related with DM. By obtaining DM listed as

contributory cause in a complete year we tried to verify the excess death of related diabetes mortality in a specific point in time. Additional analyses regarding the reduction in life expectancy among diabetic patients in Puerto Rico are warranted.

Resumen

Para determinar las características y las tendencias de la mortalidad por diabetes mellitus en la población puertorriqueña desde el año 1980 hasta el año 1997, se revisaron los certificados de defunción para aquellos residentes en Puerto Rico cuya causa inmediata de muerte fue la diabetes mellitus (ICD-9-250.0) y se extrajo la información sociodemográfica disponible. Se calculó la razón proporcional de mortalidad (PMR, por sus siglas en inglés) así como los intervalos de confianza al 95% correspondientes por género, grupo de edad, nivel de educación, y periodo de muerte. Se llevó a cabo un análisis de tendencias de la mortalidad utilizando el modelo de regresión de Poisson. Un total de 26,193 muertes fueron atribuidas principalmente a diabetes mellitus durante el periodo del estudio. Las mujeres comprendieron el 55.8% de todas las muertes relacionadas a diabetes. La diabetes alcanzó una alta proporción de las muertes entre las personas de 60 a 64 años de edad (8.14%), las de 65 a 74 años de edad (8.12%), las mujeres (7.73%) y aquellos con 1 a 6 años de educación (7.08%). El PMR aumentó considerablemente de 4.55% durante el periodo de 1980 a 1985 hasta 6.91% durante el periodo de 1992 a 1997. La mortalidad fue mayor entre los varones diabéticos con edades de 64 años o menos que entre las mujeres durante todo el periodo de 18 años. Entre el 1980 y el 1991, las mujeres entre los 65 a 74 años de edad tuvieron una mortalidad mayor que los varones, sin embargo, la mortalidad aumentó entre los varones dentro del mismo grupo de edad durante el periodo de 1992 a 1997. Cuando se examinó el grupo de edad mayor (≥75 años), los varones tuvieron una mortalidad mayor durante el periodo 1986-1997, mientras que las mujeres tuvieron un ligero aumento durante el periodo del 1980-1985. Los resultados indican que la mortalidad por diabetes ha ido aumentado marcadamente en la población puertorriqueña, principalmente entre las personas con 65 años de edad o más. Se necesitan otros estudios para evaluar los determinantes de la mortalidad por diabetes.

Acknowledgments

We thank Dr. Lillian Haddock, Professor Emeritus, for her review of the manuscript and Dr. José Hawayeck, Dean for Academic Affairs of the Medical Sciences Campus, for his support. Special thanks to Luis A. Rodríguez-Lugo and to Pamela E. Pereira-Zamora for their valuable research assistance.

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