Mortality of patients with type 2 diabetes in Taiwan: A 10-year nationwide follow-up study

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ABSTRACT

Aims: This study aims to investigate the distribution of underlying-causes-of-death (UCOD) among deceased patients with type 2 diabetes mellitus (DM) in Taiwan and assess the influence of socio-demographic characteristics on mortality in type 2 DM patients.

Methods: A cohort study on patients who sought medical care for type 2 DM from 2000 to 2008 was conducted on 65,599 type 2 DM patients retrieved from the 1-million beneficiaries randomly selected from Taiwan's National Health Insurance Database. The study cohort was then linked to Taiwan's Mortality Registry to ascertain the patients who died between 2000 and 2009. We examined the distribution of UCOD in the deceased subjects. The hazard ratios of mortality in relation to socio-demographic characteristics were estimated from Cox proportional hazard model.

Results: The leading causes of death in type 2 DM included neoplasm (22.68%), cardiovascular diseases (21.46%), and endocrine diseases (20.78%). Male gender and older ages were associated with significantly increased risk of mortality. In addition, lower urbanization and greater co-morbidity score were also significantly associated with an increased risk of mortality with a dose-gradient pattern.

Conclusions: Neoplasm accounts for the largest portion (22.68%) of deaths in type 2 DM patients closely followed by with cardiovascular diseases (21.46%). An increased risk of mortality in type 2 DM patients in lower urbanized areas may reflect poor diabetes care in these areas.

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1. Introduction

Diabetes mellitus (DM) is an epidemic disease in the world. Marked changes in human health behaviors and lifestyle have resulted in higher incidence and prevalence of DM [1]. It has been recently estimated that the global prevalence of diabetes is 8.3% [2]. The number of people with diabetes is also rising because of population growth, aging, urbanization, and increasing prevalence of obesity and physical inactivity. The potential for increase in patients with diabetes is greatest in Asia [3].

Type 2 DM has become an important public health threat for the ethnic Chinese population living in mainland China, Hong Kong, Taiwan, and Singapore, with a prevalence of one-fifth of the adult population [4]. Given the genetic susceptibility and rapid westernization of food and lifestyle, a striking increase in incidence and prevalence of type 2 DM is anticipated [5]. The rapid increase in incidence and prevalence of type 2 DM is a health or medical issue and an economic and social problem for most governments. In developed countries, the largest increase in the number of type 2 DM is recorded in the elderly population aged more than 65 years, but the larger part of new onset type 2 DM occurred in the 45–64 year old population,[2] who are vulnerable to premature death from various complications related to DM.

Increased public awareness on the adverse health consequences of type 2 DM has resulted in intensive monitoring and aggressive clinical management of DM worldwide. However, type 2 DM still accounts for a considerable number of deaths from discrete complications each year globally. Hence, cause-specific mortality statistics based on the underlying-cause-of-death (UCOD) recorded on the death certificate are important to compare the cause-of-death statistics between countries and across time. Most countries follow the guidelines determined by the World Health Organization (WHO) and would register mortality data according to the UCOD [6]. The UCOD is characterized as the disease or injury that triggers the sequence of morbid events leading directly to death. Information on the UCOD of diabetic patients may help estimate the disease burden of DM.

Although several previous studies have suggested an association between urbanization and higher type 2 DM incidence [7,8], only few studies have examined the association of urbanization with mortality in DM. Taiwan introduced a universal health insurance to cover all citizens in 1995. The national health insurance (NHI) program was intended to assure the accessibility of health care at acceptable cost [9] and eliminate the financial barrier that prevents the poor from receiving health care services. Recognizing the association between urbanization and mortality in patients with type 2 DM under the above medical care system is important. This study aimed to investigate the distribution of UCOD in a nationally representative sample of type 2 DM patients. In addition, this study also sought to assess the influence of urbanization on the risk of mortality in patients with type 2 DM.

2. Methods

2.1. Source of data

Data investigated in this study were retrospectively retrieved from the medical claims of the National Health Insurance Research Database (NHIRD) provided by the Bureau of National Health Insurance (BNHI). NHIRD provides all inpatient and ambulatory medical claims for about 99% of Taiwanese [10]. To confirm the accuracy of claim files, the BNHI performs periodical expert reviews on a random sample for every 50–100 ambulatory and inpatient claims [9]. Therefore, information attained from NHIRD is complete and accurate [11,12]. We used the medical claims data from 1997 to 2009 to obtain a representative sample of one million people randomly selected from all beneficiaries registered in 2000. Using the scrambled personal identification number; all NHI datasets can be interlinked and linked externally to Taiwan's Death Registry (TDR). Access to research data has been reviewed and approved by the Review Committee of the National Health Research Institute.

In Taiwan, the law dictates that all live births and deaths must be registered within 10 days. The TDR is considered exact and complete because registering deaths in Taiwan is necessary for physicians to complete death certificates [13]. We retrieved the information on the date of death and UCOD for each deceased individual.

2.2. Study cohorts and covariates

The study cohort consisted of all patients who sought inpatient or outpatient care for type 2 DM. Patients with type 2 DM were determined by the diagnostic codes of diabetes (International Classification of Disease, 9th Version Clinical Modification (ICD-9-CM): 250×0 or 250×2). If a patient had the code for type 2 DM at the time of discharge or had more than three ambulatory care claims for type 2 DM within a 1-year period, he or she was considered suitable for inclusion in the study. We limited our patients to those who had at least three ambulatory claims to avoid unexpected inclusion of miscoded patients from outpatient settings [14]. We obtained a total of 66,108 patients with an ambulatory claim for type 2 DM from 2000 to 2008. We also identified 38,854 patients with type 2 DM from inpatient claims. We excluded patients with ages less than 30 years ($n = 2950$) to avoid potential contamination by type 1 DM. Patients diagnosed with type 1 DM from 1997 to 2008 were also excluded ($n = 4918$). Finally, 65,599 patients with prevalent type 2 diabetes were included in the analysis. The flow chart for the cohort setup is shown in Fig. 1.

The index date for each study patient was the date when he or she received inpatient or outpatient care for type 2 DM. Covariates analyzed in this study included gender, age, urbanization, and co-morbidity indicated by Charlson's score. Age was determined on the index date. Information on a patient's underlying illnesses was retrieved from inpatient and outpatient claims from the first day of 1997 up to the index date. Underlying illnesses included all diseases used to calculate the Charlson's score, which is a weighted summary measure of clinically important concomitant diseases that has