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Physical activity is associated with decreased incidence of chronic kidney disease in type 2 diabetes patients: A retrospective cohort study in Taiwan

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ABSTRACT

Aims: To assess the effect of physical activity in patients with type 2 diabetes mellitus on prevention of diabetes with chronic kidney disease.
Methods: This is a cohort study on stratified selected subjects in Taiwan from 2004/01/01 to 2005/12/31. Demographic data, lifestyle factors and clinical characteristics were analyzed for an association with the occurrence of chronic kidney disease. Applicable analysis weights, Stata 11.0, were applied to adjust the design variables for clustering and stratification.
Results: During the two year study period, the univariate Cox proportional hazards model showed significant associations of age, physical activity, and the Charlson comorbidity index (CCI) with chronic kidney disease. Physical activity had a beneficial effect in diabetic subjects with chronic kidney disease (HR: 0.31, $p < 0.01$). Older age and a CCI greater than 2 were both harmful in diabetic subjects with chronic kidney disease (1.06 and 3.44, respectively). The results of a multivariate Cox proportional hazards evaluation model were similar to those of a univariate evaluation model, except that CCI was not significantly different. Moreover, medications for hypertension of diabetic subjects created an increased risk of chronic kidney

Abbreviations: CCI, Charlson comorbidity index; CHF, chronic heart failure; CKD, chronic kidney disease; CVD, cardiovascular disease; ESRD, end-stage renal disease; UAE, urinary albumin excretion.

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disease (HR: 5.85 and 3.74, respectively), indicating that the presence of hypertension is a strong risk factor for the progression of chronic kidney disease.
Conclusion: In this study, physical activity was not only a healthful lifestyle factor but also a treatment to decrease incidence of chronic kidney disease in diabetic patients.
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1. Introduction

In recent years, type 2 diabetes mellitus has been increasing dramatically around the world. The World Health Organization (WHO) has predicted that the number of patients with type 2 diabetes mellitus will be over 350 million by 2030. Diabetes mellitus is strongly related to macrovascular and microvascular complications of chronic kidney disease (CKD) becoming a huge burden to society. Diabetes with chronic kidney disease is found frequently as a microvascular complication in diabetic patients. Chronic kidney disease is a leading cause of end-stage renal disease (ESRD) [1] and cardiovascular disease (CVD) [2]. In 2012, the United States Renal Data System (USRDS) indicated that the per person per year costs in Medicare of chronic kidney disease with diabetes and chronic heart failure (CHF) was higher than CKD alone ($37, 490 and $15, 607, respectively). Diabetic patients with chronic kidney disease were more frequent in Asia than in Western countries [3]. Patients with static blood glucose, blood pressure, and serum lipid levels could diminish the progression of chronic kidney disease in diabetic patients [4].

For decades, lifestyle modifications were not only the primary means of prevention of diabetes, but also suppressed the course of diabetes and its complications. The pathogenesis of chronic kidney disease in diabetic patients was affected by many lifestyle factors, including diet, physical activity and healthy behavior. The mechanisms are complex. Among dietary factors, excessive consumption of protein, lipid, and sodium will enhance the progression of diabetic nephropathy [4]. Microalbuminuria is the initial symptom of chronic kidney disease in diabetic patients and excessive consumption of dietary protein could increase urinary protein excretion [1]. Especially in diabetic patients with microalbuminuria, consumption of red meat increased urinary albumin excretion and serum cholesterol [5].

In addition to diet and medication, exercise was also an efficient treatment for type 2 diabetes mellitus [6]. Several studies have demonstrated that regular aerobic exercise may not only increase high density lipoprotein (HDL) cholesterol [7,8] but also decrease total cholesterol, low density lipoprotein (LDL) cholesterol, and triglyceride levels [7]. Furthermore, previous studies showed that exercise could improve insulin sensitivity [8], glycaemic control, and blood pressure [9,10]. The American Diabetes Association (ADA) in 2010 reported that physical activity induced urinary protein excretion rapidly [11]. In an animal model, exercise prevented the pathogenesis of diabetic nephropathy in diabetic rats [12], but there are insufficient data regarding this issue in humans. Therefore, the objective of this research was to assess the effect of physical activity in patients with type 2 diabetes mellitus on prevention of chronic kidney disease.

2. Methods

2.1. Study population

This was a cohort study of demographic data, lifestyle factors and clinical characteristics of stratified selected subjects in Taiwan from 2004/01/01 to 2005/12/31. All subjects beyond 12 years old had participated in a questionnaire by the Taiwan National Health Research Institute. This cohort study was approved by the Institutional Review Board (IRB) of Chung Shan Medical University Hospital. The age, sex, body mass index (BMI), education, physical activity, alcohol drinking and smoking habits, past history, family history, and simple food frequency of each subject were requested by the questionnaire. The World Health Organization (WHO) has stated that physical activity includes activities of skeletal muscles that induce body movements that require energy consumption, including walking, cycling, and so on. In our questionnaire, the subjects who had the above activities had physical activity in this study. Alcohol drinking (Yes) included both current drinkers and ex-drinkers, and smoking habits (Yes) also included both current smokers and ex-smokers. Married (No) included both widowed and divorced subjects. Past history included past medical records and questionnaire survey, but family history of diabetes, hyperlipidemia, hypertension, and heart failure only related to this questionnaire survey. Dietary questionnaires included 24-h dietary recall, food frequency, dietary habits, and dietary supplements [13]. About the study design and sampling methods had identified and provided by the Nutrition and Health Survey in Taiwan (NAHSIT) [13]. In this study, the database had obtained the agreement from all subjects to link to the Taiwan National Health Insurance Research Database. We identified all subjects with a diagnosis of diabetes (including ICD-9-CM = 250 for Outpatient department visits ≥ 2 or admission ≥ 1 during 2004–2005) and non-chronic kidney disease (excluded were ICD-9-CM = 580–589 and 250.4 for Outpatient department visits ≥ 2 or admission ≥ 1 during 2004–2005) in the ICD-9-CM coding system during the study period from 2006/01/01 to 2007/12/31. The effect of medications for hypertension and dyslipidemia were also considered.

2.2. Statistical analysis

The data were expressed as the mean ± S.D. Applicable analysis weights, Stata 11.0, were applied, to adjust the design variables for clustering and stratification. The Cox proportional hazards model was used to identify the influence of baseline characteristics on diabetic subjects. The results of all tests with $p < 0.05$ were considered to be statistically

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