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Original article

Medical cost of type 2 diabetes attributable to physical inactivity in the United States in 2012

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ABSTRACT

Aims: Type 2 diabetes has grown to epidemic proportions in the U.S. and physical activity levels in the population continues to remain low, although it is one of the primary preventive strategies for diabetes. The objectives of this study were to estimate the direct medical costs of type 2 diabetes attributable to not meeting physical activity Guidelines and to physical inactivity in the U.S. in 2012.
Methods: This was a cross sectional study that used physical activity prevalence data from the Behavioral Risk Factor Surveillance System to estimate the population attributable risk percentage for type 2 diabetes. These data were combined with the prevalence and cost data of type 2 diabetes to estimate the cost of type 2 diabetes attributable to not meeting physical activity Guidelines and to inactivity in 2012.
Results: The cost of type 2 diabetes in the U.S. in 2012, attributable to not meeting physical activity guidelines was estimated to be $18.3 billion, and that attributable to physical inactivity was estimated to be $4.65 billion. Based on sensitivity analyses, these estimates ranged from $10.19 billion to $27.43 billion for not meeting physical activity guidelines and $2.59 billion–$6.98 billion for physical inactivity in the year 2012.
Conclusions: This study shows that billions of dollars could be saved annually just in terms of type 2 diabetes cost in the U.S., if the entire adult population met physical activity guidelines. Physical activity promotion, particularly at the environmental and policy level should be a priority in the population.

1. Introduction

Physical inactivity is a major risk factor for myriad chronic diseases. There is a strong body of evidence to suggest that regular physical activity significantly reduces the risk of cardiovascular disease, type 2 diabetes mellitus, stroke, breast cancer, and colon cancer [1]. Physical inactivity negatively affects quality of life by contributing to the development of obesity, osteoporosis, depression, and anxiety [1]. Most Americans are currently leading a sedentary lifestyle. Despite its role in significantly reducing the risk of many chronic diseases, physical activity levels have remained fairly constant over the last few years in the United States. The prevalence of regular physical activity (recommended amount) in the U.S. adults only increased slightly from 2001 (48%) to 2013 (50.2%) [2,3].

With increased health risks, physical inactivity is intuitively associated with higher health care costs. The direct medical expenditures associated with physical inactivity in the U.S. were estimated to be $131 billion/year from 2006 to 2011 [4]. This is comparable to the direct medical expenditures associated with tobacco use in the nation, which was estimated to be $175 billion in 2013 [5]. Hence, in an effort to recognize the importance of incorporating regular physical activity, the United States Department of Human Health Services published physical activity Guidelines for Americans in 2008. According to these Guidelines, all adults are recommended to accumulate at least 150 min per week of moderate-intensity activities or 75 min per week of vigorous-intensity activities [6].

Diabetes was the seventh leading cause of death in the U.S. in 2010, and the overall risk of death among people with diabetes is about twice that of people without diabetes of the same age [7]. Further, there were 1.7 million new cases of diabetes (Type 1 and 2) in 2012 among people aged 20 years or older. The prevalence of diagnosed diabetes in the U.S. was 21 million in 2012 and as many as 8.1 million people were estimated to have undiagnosed diabetes in the same year. Approximately 90–95% cases were Type 2

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diabetes and the rest were Type 1 diabetes. In all, 9.3% of the total population in the United States had diabetes in 2012 [7].

Diabetes is associated with long-term complications at both macro-vascular and micro-vascular levels. Diabetes is the leading cause of new cases of blindness among adults aged 20–74 years, as well as the leading cause of kidney failure. The risk of stroke and deaths due to heart disease are 2–4 times higher in diabetics as compared to non-diabetics [7]. Other complications of diabetes include high blood pressure, nervous system impairments, amputations, dental disease, and increased susceptibility to infections [7].

Due to numerous long-term complications associated with diabetes, the economic burden of the disease is huge. The total estimated cost of diabetes in the U.S. in 2012 was $245 billion ($176 billion – direct cost, and $69 billion – indirect cost) [8]. Huang et al. predicted the number of people with diagnosed and undiagnosed diabetes in the United States to increase to 44.1 million by 2034, even with assumptions of obesity rates remaining stable over that period. During the same period, direct annual diabetes related spending is expected to triple to $336 billion [9].

Type 2 diabetes is a chronic disease characterized by persistent and progressive deterioration of glucose tolerance. Insulin resistance and impaired insulin secretion have been implicated in its development. Although genetic variants predispose to impaired beta cell function of pancreas, toxic effects of elevated levels of glucose and free fatty acids precipitate and worsen such predisposition [10]. Regular physical activity improves glucose tolerance and insulin sensitivity by improving glucose metabolism and reducing free fatty acid levels [11,12].

Several intervention studies have shown that regular moderate-intensity and/or vigorous-intensity activities can significantly reduce the risk of Type 2 diabetes [13–15]. In an attempt to determine whether exercise and diet interventions are effective in reducing the incidence of Type 2 diabetes in individuals with impaired fasting glucose, a randomized clinical trial was conducted in China. They reported 46% and 31% risk reduction of developing diabetes for exercise and diet interventions, respectively [14]. The Finnish Diabetes Prevention Study, a randomized controlled trial of lifestyle changes, demonstrated the effect of leisure time physical activity (LTPA) on reducing the incidence of type 2 diabetes. The participants with levels of moderate to vigorous LTPA greater than 150 min/wk were 44% less likely to develop diabetes than those remaining sedentary (less than 60 min/wk) [15].

Despite the high prevalence, substantial disease burden and effectiveness of physical activity in reducing the risk of Type 2 diabetes, no data exist to estimate the population-wide cost of Type 2 diabetes attributable to physical inactivity. The primary aim of this study was therefore to estimate the cost of type 2 diabetes in the U.S. attributable to not meeting physical activity Guidelines and to physical inactivity, in 2012. The secondary aims of this study were: 1) to estimate the range of cost of type 2 diabetes attributable to not meeting physical activity Guidelines in the US in 2012 by a) varying the average annual cost of the disease, and b) varying the prevalence of people meeting Guidelines. 2) to estimate the range of cost of type 2 diabetes attributable to physical inactivity in the US in 2012 by varying the average annual cost of the disease.

2. Methods

We used a cross sectional study design for this research. Not meeting physical activity Guidelines and physical inactivity were considered the “exposure” variables. Not meeting physical activity Guidelines was defined as the 2013 percent of adults who did not achieve at least 150 min a week of moderate-intensity aerobic physical activity or 75 min a week of vigorous-intensity aerobic activity (or an equivalent combination). We used the 2013 prevalence data for not meeting guidelines for 2012 since BRFSS questionnaire did not include this variable in 2012 and prevalence has not changed much in the last decade. Physical inactivity was defined as the 2012 prevalence of adults who reported spending no time in LTPA. The outcome variable was the direct medical cost of type 2 diabetes attributable to the two exposures.

The prevalence of not meeting physical activity Guidelines and physical inactivity in the US were obtained from the 2013 and 2012 Behavioral Risk Factor Surveillance System (BRFSS) data respectively [3,16]. As per the BRFSS, a respondent is classified as not meeting guidelines if he/she responds “no” to achieving at least 150 min a week of moderate-intensity aerobic physical activity or 75 min a week of vigorous-intensity aerobic activity (or an equivalent combination). Those who respond “no” to engaging in any LTPA in the past month are classified as engaging in no LTPA. The BRFSS is a state-based system of health surveys that collects information on health risk behaviors, preventive health practices, and health care access primarily related to chronic disease and injury. Data are collected by random-digit-dialed telephone survey of the non-institutionalized, U.S. civilian population aged 18 years and above. Data are collected from the 50 states, District of Columbia, Puerto Rico, and the U.S. Virgin Islands.

Data from the American Diabetes Association (ADA) study were abstracted to estimate the number of diagnosed and total (diagnosed plus undiagnosed) cases of type 2 diabetes among the US adults (age 18 years and above) in 2012 [8]. The average annual medical cost of an individual with diabetes in the year 2012 was obtained from the same study [8].

2.1. Data analysis

We used the Levin's formula to calculate the population attributable risk (PAR) percentage, according to which PAR $\% = (pe(RR-1)/pe(RR-1)+1) \times 100$; where pe is the prevalence of exposure in the population, and RR is the relative risk in the exposed population compared to the unexposed population [17]. The relative risk for type 2 diabetes for people not meeting Guidelines compared to those meeting Guidelines was used from a systematic review done in 2007 [13]. There have been only three studies we were able to locate, which have estimated the relative risk of type 2 diabetes for no activity versus some activity [18–20]. The most conservative risk estimate was used from those studies.

We used two different relative risks for all the analyses, BMI-unadjusted and BMI-adjusted. The BMI-unadjusted relative risks were adjusted for multiple covariates like age, smoking, alcohol consumption, hypertension, cholesterol levels, and family history of diabetes, but not for BMI. The BMI-adjusted relative risks were adjusted for BMI and the above-mentioned covariates.

Using the prevalence of not meeting Guidelines, physical inactivity, and the respective relative risks, the PAR% for not meeting physical activity Guidelines and for physical inactivity were estimated for the US. The resultant PAR% estimates the percentage of type 2 diabetes cases that would have been prevented if the prevalence of exposure was zero (that is – if 100% population were meeting Guidelines/not completely inactive). The PAR% were applied to the total number of type 2 diabetes cases in the United States to calculate the number of cases that would have been prevented for two different cases: i) if 100% population were meeting Guidelines, and ii) if 100% population were not inactive. The number of cases prevented were multiplied with the annual medical cost of a person with diabetes in 2012 to estimate the total cost of type 2 diabetes in the US in the year 2012, attributable to: i) not meeting physical activity Guidelines, and ii) physical inactivity (for primary aim).