Original Article

Population attributable risk of risk factors for type 2 diabetes; Bayesian methods

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ABSTRACT

Objective: Demonstrating the risk factors of diabetes can help to plan for prevention of this disease. This study aimed at quantification of the impact of physical activity, hypertension, general obesity, central obesity, high cholesterol, HDL, LDL, triglyceride, smoking, hookah, drug use, alcohol consumption on the incidence of type 2 diabetes at a population level in Yazd, Iran. And this study calculated population attributable risk (PAR) of them.

Methods: For this study, data from the first phase of the cohort study of chronic diseases in the adults of Yazd city were used, which began in 2016. Data was recorded through a cohort trained team. To calculate PAR and its the Bayesian confidence interval were performed using software R (version 3.4.3).

Results: Of the 9967 subjects studied, age ≥ 30, 14.67% (n = 1432) has type 2 diabetes. The most common risk factors for diabetes were Inadequate physical activity and central obesity (WHR). The PAR for Inadequate physical activity of diabetes in women was 17.92%, in men 18.53, And PAR for WHR in women was 57.62%, in men 43.03.

Conclusions: In this study, age was the strongest determinant of diabetes. And then type 2 diabetes is mainly attributable to WHR, significantly more so in women than men. Therefore, central obesity probably should be considered as a major strategy for reducing incidence of type 2 diabetes.

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1. Introduction

Diabetes is the most prevalent metabolic disease that reduces life expectancy by a third [1,2]. The most common type of diabetes is in adults and is known as type 2 diabetes [3]. It occurs when the body is resistant to insulin or does not produce enough insulin. According to the World Health Organization (WHO), the prevalence of diabetes is projected to increase from 4% in 1995 to 4.5% in 2035, and in developing countries, the number of patients rises from 84 million to 228 million [4]. According to the World Health Organization's website, in the Eastern Mediterranean region, where Iran is one of the countries of this region, the prevalence of diabetes in the adult population of the region was 14.5% in 2003. The number of people with diabetes in Iran is about 2 million. One hundred thousand people were in 2000 and will reach about 6,400,000 in 2030 [5]. Over the past three decades, the prevalence of Type 2 diabetes has increased dramatically in developing countries, but appropriate interventions to control the disease have not been implemented [6].

Epidemiological research allows us to understand the relation between disease and exposure to risk factors, such as lifestyle, educational and occupational conditions. A type of statistic used in epidemiological studies to measure the relationship between risk factors and disease is a population attributable risk (PAR) [7]. PAR is calculated as follows:

$$PAR = \frac{P(D_+) - P(D_+|E_-)}{P(D_+)}$$

In this equation, D (+/-) indicates the condition of the disease and E (+/-) indicates the state of exposure [8]. This formula is rewritten using the Bayes theorem:

$$PAR = \frac{P(E)(RR - 1)}{1 + P(E)(RR - 1)}$$

P (E) represents the probability of exposure, and RR represents relative risk [9]. This measure is one of the most valuable concepts for activists in the public health field and, as a measure that combines the prevalence and severity of the effect of the risk factor of a disease allows us to determine the overall effect of a specific exposure in the community, and in some cases use preventive measures [7]. In the past, this index was rarely used in research, since there was no single definition of PAR in common statistical packages and could not easily be calculated. Even if there is a proper method, the method that could be used to calculate the PAR for that confidence interval was unavailable [10]. Since in the natural sciences and especially medicine, much importance is attached to the previous information, in the present study, the risk factors for type 2 diabetes were calculated using Bayesian, PAR and its relative confidence intervals [11].

2. Methods

For this study, data from the first phase of the cohort study of chronic diseases in the adults of Yazd city were used. This study was conducted in 2016 with the aim of investigating non-invasive diseases such as diabetes and its related risk factors in Shahediyeh district of Yazd. This region was selected according to conditions such as availability of people, non-immigrants of other cities, intact ethnicity and indigenous cooperation. Data was recorded through a cohort trained team. In order to collect information, at first the residents of the region who were over the age of 30 were asked to visit their predetermined places. And in case residents were not available at the place, the agents were referred to their homes. There was no compulsion to participate in the study. No charges were received from anyone and all costs were paid from study credits. In this study, data on 9852 people were used. This data includes several sections that were collected using questionnaires, clinical examinations, blood and urine tests, and paraclinical tests. Variables include demographic characteristics, records of chronic diseases, consumable drugs, blood pressure, sleep, physical activity, individual habits and anthropometric data recorded by the physician.

The American Diabetes Association (ADA) annually publishes the latest criteria for diabetic diagnosis in the Journal of Diabetes Care. ADA believes that a definitive diagnosis of diabetes is possible only with the help of a clinical laboratory, and its diagnostic criteria are quite laboratory. According to this statement, the criteria for diabetic diagnosis in this article are as follows: Plasma glucose in fasting state equal to or greater than 126 mg/dL [12].

An International Physical Activity Questionnaire (IPAQ) was used to measure and evaluate the physical activity of each person. The IPAQ-L questionnaire is used in different countries and its reliability and validity are confirmed in Iran. In the previous study, Spearman correlation coefficient 0.9 was compared with the original reliability of the questionnaire and the Cronbach's alpha coefficient was 0.7, which indicates a good fit for this tool [13]. Total MET was calculated for the ranking of people according to the questionnaire's recipe. If the calculated value is less than 600 MET-minutes/week, the physical activity at a distance (600, 3000) MET-minutes/week is a moderate physical activity and if it is more than 3000 MET-minutes/week, there is a severe physical activity [14]. To study the effect of inadequate physical activity on diabetes, two high and medium physical activity groups were merged.

In this study, two types of obesity namely general and central obesity were used to assess the effect of obesity on diabetes. Body mass index (BMI) was used to measure the obesity index. Individuals with 30 < MBI were divided into non obese subjects with BMI> 30 in obese individuals [15]. To assess the effect of central obesity on diabetes, the ratio of waist to hip ratio was used, with a ratio of above 0.95 for men and a higher than 0.90 central obesity for women [16].

Mercury pressure gauge was used to measure blood pressure. The systolic and diastolic blood pressure of individuals was measured two times in sitting position from the right arm and the mean of the two obtained was reported as the blood pressure of individuals. Hypertension was considered to be more than 140 to 90 mmHg. Also, after measuring blood glucose levels and comparing each of them with the relevant critical values, HLD <35 mg/dl, LDL> 130 mg/dl, TG > 200 mg/dl and CHOL> 200 mg/dl, the subjects were identified.

Information about smoking was also gathered. People who smoked in the past or on a daily or occasional basis were considered as smokers. Also, people who used hookahs, drugs and alcohol in the past were people who were exposed to these risk factors [17].

All statistical analyzes were performed using software R (version 3.4.3). It was also used to calculate PAR and the Bayesian confidence interval for those Matrix and MCMCpack packages. Considering that in the Bayesian method, we consider a previous distribution with Dirichlet (1, 1, 1, 1). The input data of these functions is in the form of 2 × 2 tables. You can calculate the confidence interval for each confidence level, where the 95% confidence level is considered here [18].

3. Results

The total number of participants in this study was 9967, of which 49.56% (4939 people) were woman and 50.46% (5028 people) were male. Mean and standard deviation of age was 48.83 ± 9.67 years. 14.67% (1432 persons) of the subjects were type II diabetes. The most common risk factors for diabetes among women were central obesity, high LDL, and inadequate physical activity, respectively. In men, smoking was the most common risk factor for diabetes, followed by high LDL and central obesity in the second and third place. It should be noted that four risk factors: alcohol consumption, smoking, hookah smoking and drug use among women had a high incidence of inactivity. According to Table 1, Chi-square test showed that there was a significant difference in the prevalence of risk factors for type 2 diabetes, with the exception of high LDL in both sexes. The greatest difference was in the prevalence of cigarette smoking risk factors. This was 50.87% higher in men than in women. Due to a significant difference in the prevalence of diabetes risk factors among men and women, calculations were performed for both sexes separately.

According to Table 2, the highest PAR in diabetes is associated with an unmodifiable risk factor, namely, age. And then focused on central obesity. In males, PAR is related to three risk factors for smoking, alcohol and hookah consumption, and in women, there is a negative risk factor for alcohol use. Of course, the numerical value of these risk factors for the development of type 2 diabetes in the subjects resulted in a small PAR.

The estimated risk for all risk factors, with the exception of low HDL, alcohol consumption and drug use, was numerically higher in women than in older men.

4. Discussion

According to recent studies on type 2 diabetes risk factors, physical activity, hypertension, general obesity, central obesity, high cholesterol, HDL, LDL, triglyceride, smoking, hookah, drug use, Alcohol consumption in this study was considered as modifiable risk factors and age as an unmodifiable risk factor.

The current PAR-related BMI study in women was 14.27%, in men 7.45%, in PAR-related to WHR was 57.62 for women, and 43.03 for men. In the study of L. He et al. in India, China and Japan, the

Table 1
Type 2 diabetes Prevalence & risk factors by gender.

Prevalence				
Risk Factors	Female	Male	Overall	p- value
Diabetes	15.19	14.15	14.67	<0.0005
General Obesity	44.90	23.01	33.87	<0.0005
Central Obesity	61.84	46.06	53.88	<0.0005
Inadequate Physical Activity	62.21	54.27	58.21	<0.0005
High blood pressure	23.39	19.17	21.25	<0.0005
High Cholesterols	37.51	33.69	35.62	<0.0005
HDL	2.99	8.82	5.92	<0.0005
LDL	46.25	46.53	46.39	0.759
Triglyceride	21.68	28.82	25.27	<0.0005
Cigarette	1.26	52.13	33.69	<0.0005
Alcohol	0.32	15.39	7.92	<0.0005
Hookah	4.08	35.18	19.77	<0.0005
Drug	1.11	29.73	15.55	<0.0005

Table 2
Estimated population risk for type 2 diabetes mellitus risk factors by gender.

PAR% (Bayes CI)		
Risk Factors	Female	Male
BMI	14.27 (8.34, 20.29)	7.45 (3.53, 11.49)
WHR	57.62 (50.79, 64.07)	43.03 (36.94, 49.06)
Inadequate Physical Activity	17.92 (11.15, 25.88)	18.53 (9.67, 25.94)
High Blood Pressure	29.93 (25.53, 34.45)	21.16 (17.06, 25.34)
High Cholesterol	1.42 (3.22, 8.56)	5.82 (−0.72, 3.75)
HDL	0.80 (−0.40, 2.17)	3.63 (1.31, 6.13)
LDL	12.31 (6.14, 18.36)	10.07 (3.40, 16.64)
TG	23.83 (19.75, 27,93)	18.68 (13.96, 23.48)
Cigarette	0.96 (−0.88, 3.81)	−4.83 (−14.63, 4.84)
Alcohol	−0.08 (−0.36, 0.34)	−3.76 (−6.41, −0.82)
Hookah	0.99 (−0.41, 2.57)	−7.67 (−12.55, −2.68)
Drugs	0.49 (−3.20, 5.84)	1.27 (−0.23, 1.39)
Age	63.91 (57.85, 69.43)	64.80 (58.40, 70.93)

calculated PAR for BMI in all three countries is higher than the calculated value in this study, but the PAR for WHR in India is 37.80%, in China 52.36, and In Japan, it was 61.01% [19]. The study of Hart et al., Conducted in 2007 on diabetic patients, did not precisely calculate PAR, but showed that about 60% of diabetes cases were preventable by overweight [20]. also in the study of KNUT ODE-GAARD et al. Who calculated PAR for obesity in diabetic patients, reported 51.5% of diabetic patients referred to obesity [21].

In a study done by Hmwe H. Kyu and colleagues, they examined 55 articles about physical activity and the risk of diabetes. The study suggests that individuals with inadequate physical activity are more at risk for diabetes [22]. In a study by Michael J. LaMonte et al., among people with impaired fasting glucose or diabetes mellitus, compared to healthy people, we face with a lower level of physical activity [23]. In this article, PAR has an inadequate physical activity of 17.92% for women and 18.53% for men. Therefore, 17.92 percent of the incidence of type 2 diabetes in the entire female population can be attributed to inadequate physical activity, and if an effective prevention program can increase the level of physical activity, in the best of cases, it would be hoped that a maximum of 17.92 percent of the incidence of type 2 diabetes and the total number of women in two is reduced. It is also true in men.

Similarly, PAR was associated with hypertension in women of 29.93% and in men of 21.16%. In the cohort study of Tehran Lipid and Glucose Study, which was performed on 5801 people over 30 in 2011, the prevalence of hypertension in men and women was 27.2 and 23.1, respectively. The prevalence of hypertension in men and women was 23.39 and 19.17, respectively. The numerical value of both hypertension indicators in women is higher.

One of the main causes of the burden of disease in developed and underdeveloped countries is an increase in total cholesterol. In 2008, the prevalence of hypercholesterolemia in adults was estimated at 39%. In Table 2, PAR was obtained for laboratory parameters of serum. PAR TG related to risk factors is ranked fourth. Similarly, in the study of L. He et al., TG had the largest amount of PAR in blood glucose [19]. The results of this study were in line with a study conducted in the United States.

The prevalence of smoking, hookah smoking, drug use, and alcohol consumption among women is very low, and PAR is not considered to be a type 2 diabetes. The high prevalence of tobacco use by women in Western countries makes the findings of this study not comparable to that of European countries [24]. The rate of non-response to these risk factors was very high among women, with only 10% of the women registered. The low prevalence of these risk factors in women can be attributed to their lack of response and cultural differences with other countries. The prevalence of smoking in men is 52.13%. In the population of the study, the numerical value of PAR was related to smoking, which according to the confidence interval at the significant level of 0.05, there was no significant relationship between smoking and type 2 diabetes. PAR consumption of alcohol in men was −3.76%, which indicates the protective effect of this risk factor.

In this study, age was the strongest determinant of diabetes. PAR The high-risk age in men and women was 63.91 and 64.80 respectively. Part of the magnitude of this risk factor can be due to stress, hormonal changes, cardiovascular disease, and so on, which occurs at an early age. Another part, even taking into account all possible risk factors, is caused only by age, which makes it

impossible to control and prevent this part of the risk of diabetes.

The strength of this study is that information from a large study on a large sample of society has been used. As a limitation of the study, the inclusion of information on the family history of diabetes in the participants was not recorded. Similarly, in this study, instead of measuring physical activity based on the metabolic score, information was collected by a questionnaire, and the physical activity calculated in this study may not reflect the actual status of individuals.

5. Conclusion

In the context of preventive measures, population attributable risk is one of the key concepts in general health and clinical practice. Preventive interventions based on sex are better because of the different risk factors for diabetes in men and women. While trying to control all of the risk factors mentioned above and due to the high prevalence of obesity in this study and the difference in the study with other countries, more serious programs have to be taken to control this risk factor and its effect on type 2 diabetes. If an effective prevention program can eliminate all risk factors for diabetes, in the best of terms, it is hoped that a significant reduction in the incidence of diabetes in the entire population happened.

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