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ORIGINAL ARTICLE

Variability of the Type II Diabetes Mellitus Incidence Rate of Population of Cities in the Republic of Azerbaijan

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KEYWORDS

Incidence rate;

Type II diabetes mellitus;

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ABSTRACT: The purpose of the study is comparative assessment of type 2 diabetes mellitus incidence rate among population of cities of the Republic of Azerbaijan. Study was carried out in main cities of republican subordination. The unit of statistical observation was a patient with confirmed and newly diagnosed T2DM. Standardised incidence rate of T2DM by age was calculated by direct standardisation method. Variability of incidence rate of Azerbaijan population was estimated. The highest incidence for 2012 year was identified among population of Naftalan and the lowest – in the city of Ganja. As the result of comparison significant difference between cities Sumgayit, Shirvan and Mingachevir was not determined ($p>0.05$). In these cities the incidence rate is much higher ($p<0.01$) than in Ganja, lower than in Baku and Naftalan. The intercity difference in the standardised incidence rate of the population with T2DM remains. But at the same time volatility of standardised T2DM incidence rate (151.6) among population nearly is the same of actual incidence rate (151.3). The population risk of T2DM in cities of Azerbaijan differs from each other significantly, both due to actual and standardised coefficients. Variability of incidence rate of T2DM among population more pronounced according annual coefficients, than according average chronological coefficients and standard deviations. Volatility of incidence rate of T2DM among population can be comprehensively assessed by the level of annual, chronological average incidence rates, variability, and the size of the standard deviation.

INTRODUCTION

Diabetes mellitus (DM) – a condition defined as an increase of glucose levels in blood, the diagnostic test of which is glycated haemoglobin HbA_1C [1]. Currently, there are four main etiological categories for diabetes mellitus; T1DM, T2DM, gestational diabetes and other specific types. T1DM is defined by insulin deficiency due to the destruction of beta cells in the pancreas, leading to absolute insulin deficiency [1]. T2DM is characterised by a combination of insulin resistance and beta cell deficiency associated with obesity and a sedentary lifestyle [1]. Gestational diabetes develops during pregnancy. Other specific types of diabetes include: single gene mutations leading to rare forms of diabetes; secondary diabetes after a number of diseases (pancreatitis, trauma or pancreatic surgery); drug or chemically induced diabetes. Pre-diabetes is a condition of impaired glucose metabolism, hyperglycaemia in the fasted state and impaired glucose tolerance. This condition is only detectable by an oral glucose tolerance test (glucose 2 hours after exercise ≥7.8 mmol/L and <11.1 mmol/L). The WHO has established threshold values for the diagnosis of diabetes by the value of glucose in venous plasma, venous and capillary blood, respectively (mmol/L and mg/dL):

– increased fasting glucose: 6.1 (110); 5.0 (90) and 5.6 (101);

– impaired glucose tolerance: 7.8 (140); 6.5 (117) & 7.2 (130);

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– diabetes: 7.0 (126); 5.8 (104) and 6.5 (117) on an empty stomach;

– diabetes: 11.1 (200); 9.4 (169) and 10.3 (185) – 2 hours after taking 75 g of glucose.

The disease burden is assessed by numerous criteria, among which the most commonly used are: incidence, prevalence, mortality and disability due to disease, disability adjusted life years – DALY. Diabetes mellitus is characterised by the severity of the global burden. Taking into account the dynamic increase in the burden of diabetes mellitus (DM), the State Register has been created in many countries – an automated analytics platform of clinical and epidemiological monitoring on a nationwide scale.

Type II diabetes mellitus (T2DM) is a severe disease common in all countries of the world. Depending on the state of socio-economic development, age and sex of the population and the environmental situation, there are different dynamics and different levels of T2DM incidence in countries and regions [1-7]. The incidence rate of the population with T2DM fluctuates in the range of 9.8-25‰ according to [2], 0.4–32.4 $^0/_{000}$ according to [3]. Particularly alarming is the high incidence rate of T2DM. In Azerbaijan, during 2000-2012, the incidence rate of T2DM increased from 4.37 to 19.52‰ [6]. Many studies by Iranian scientists have been investigating various aspects of diabetes [8-19]. It is noted that in 2011 the prevalence of diabetes in Iran among the adult population was 11.4% [9]. Over 1999-2007, there was a doubling of the prevalence of diabetes [10]. It is projected that in Iran by 2030 the number of patients with diabetes will amount to 9.2 million. Therefore, Iran has begun the implementation of a diabetes prevention program [15; 16]. In the United States, there is a pronounced regional difference: there are communities where the primary incidence is less than 5% and more than 15%. The authors compared the incidence of diabetes with the prevalence of obesity in the community. No direct relationship was found between the compared indicators. So, for example, in a community where the incidence rate of 4.9%, obesity was found in 16.4% of the population. In communities with diabetes incidence rates of 7.3 and 8.0%, obesity was observed in 33.7 and 31.0% of the population. At the same time, there are communities with a high prevalence of diabetes (15.3%) and a relatively low prevalence of obesity (26.2%). Despite the noted levels of diabetes incidence and prevalence of obesity, they are mainly correlated with each other. The role of obesity as a risk factor for diabetes is considered by many authors. [20-25].

In Korea, diabetes mellitus incidence rate in 2009-2011 increased from 18.84 to 25.71‰. The dependence of T2DM incidence rate on the ethnicity of patients has been shown [2]. The role of socio-economic, demographic and environmental factors is more evident in the urban environment. An Indian research group, when examining persons >20 years old in different cities (137; 109; 135 and 142‰) and different villages (78; 65; 30 and 83‰), received data confirming the significant difference between cities, villages and between both types of settlements [26]. In some cities of India, the same prevalence of diabetes was revealed [27] (154; 153; 157 and 186‰). In Pakistan, in rural settlements among persons aged >25 years, diabetes was found in 142‰ [28], and among urban population aged 12 -80 years, the detection rate of diabetes was 131‰ [29]. In another Pakistani city, 87% were diagnosed with diabetes at the age of 30–90 [30]. In Sri Lanka, during an examination of urban residents aged 35-64 years, diabetes was detected in 247‰ cases [31]. The difference in the prevalence of diabetes in individual settlements was confirmed in the works of other researchers [32; 33]. Summarising numerous studies in cities in East Asian countries, the authors [34] confirm the high risk of diabetes mellitus. Therefore, the study of the incidence rate variability of the population in cities is relevant and important for the organisation of medical care.

The aim of the study is a comparative assessment of the incidence rate of T2DM in the cities of republican subordination of Azerbaijan.

MATERIALS AND METHODS

The research was carried out in the cities of republican subordination (Baku, Sumgayit, Ganja, Mingachevir, Shirvan and Naftalan). The cities, which are regional centres and as an administrative territorial entity, have the status of regions of republican subordination, were not included in the object of the study. Baku city is the capital of the Republic of Azerbaijan with a population of 2204.2 thousand (2015). Birth rate 15.8‰, mortality

5.7‰. The proportion of people aged 0-14, 15-29, 30-44, 45-59, 60 years and older is respectively 19.51; 25.27; 23.8; 21.0; 10.42%. The city of Sumgayit is located on the Absheron Peninsula near the city of Baku, where the population is 332.9 thousand (2015), the birth rate is 17.0‰, the mortality rate is 5.3‰, the proportion of people in the age range is 0-14, 15-29, 30-44, 45-59, 60 years and older: 22.06; 25.55; 23.41; 19.69 and 9.29% respectively. The city of Ganja with a population of 328.4 thousand, the birth rate is low (13.3‰), the death rate is relatively high (6.2‰). Share of persons in the age composition of the population: 21.12% – 0-14 years old; 26.70% – 15-29 years old; 22.40% – 30-44 years old; 19.36% – 45-59 years old; 10.42% – 60 and older.

The city of Mingachevir with a population of 101.6 thousand (2015), the birth rate is 16.4‰, the mortality rate is 6.3‰. The age structure of the population: 0-14 years old – 20.29%, 15-29 years old – 26.11%; 30-44 years old – 22.96%, 45-59 years old – 21.51%; 60 and over – 9.13%. Shirvan city with a population of 82.9 thousand (2015), birth rate 19.0 19, mortality 6.6‰. Age composition of the population: 0-14 years – 19.44%; 15-29 years old – 28.71%; 30-44 years old – 22.75%; 45-59 years old – 19.99%; 60 years and over – 9.11%. The city of Naftalan is a small town with a population of 9.7 thousand, the birth rate is 17.4‰, the death rate is 5‰. Age composition of the population: 0-14 years old – 20.45%; 15-29 years old – 25.54%; 30-44 years old – 23.08%; 45-59 years old – 20.87%; 60 and over – 10.06%. The study of the morbidity of the population on a national scale is possible only if the country has established a system for accounting all primary cases of diabetes. Before the introduction of the State Program, there was a possibility of incomplete accounting of primary cases of diabetes. The state provision of patients with medicinal products and means for glycaemic control creates good motivation for timely contacting outpatient clinics, which significantly increases the reliability of the incidence rate registration. Therefore, when studying the incidence of diabetes both on a national scale and in its administrative-territorial entities, official reports on primary cases of pathology were used, and in Baku, additional materials from the State Register. To improve the accuracy of assessing the incidence of diabetes as one of the criteria for the burden of diabetes, materials for 2000-2016 were used. The chronological average value of the incidence rate was determined (CAVIR) (Eq. 1):

$$CAVIR = \frac{\sum IRCY}{n} \qquad (1)$$

where IRCY – incidence rate by calendar years and n – the number of calendar years. Taking into account the importance of this indicator, its characteristics were obtained for all parameters of descriptive statistics: mean error and standard deviation, variance, interval, minimum and maximum values and degree of reliability.

The unit of statistical observation is a patient with a confirmed and newly diagnosed T2DM. Consideration was given to gender, age, body mass index, HbA_1C level, the duration of diabetes, its severity, as well as comorbidities in patients.

The following criteria were used to assess the severity of diabetes:

– Mild diabetes: no macro and microvascular complications of diabetes;

– Moderate diabetes: diabetic retinopathy, non-proliferative stage; diabetic nephropathy at the stage of microalbuminuria; diabetic polyneuropathy;

– Severe diabetes: diabetic retinopathy, pre-proliferative or proliferative stage; diabetic nephropathy, stage of proteinuria or chronic renal failure; autonomous polyneuropathy; macroangiopathy; postinfarction cardiosclerosis, heart failure, condition after acute disturbance of cerebral circulation, occlusive lesion of the lower limbs.

The incidence rate of the population with T2DM was calculated per 100 thousand of the population, the size of the standard deviation was determined, the 95% confidence interval (t = 1.96). The dynamics of the incidence rate was assessed by paired comparison of indicators for calendar years using the "t" criterion. The main trend was determined by the least squares method, the trend line was described by various equations (linear, exponential, logarithmic, polynomial of varying degrees, power, and others) for approximation, among which the most accurate equation was chosen. The criterion for the accuracy of the equations was the discrimination coefficient (R^2). To describe the trend line, a regression equation was selected with maximum accuracy (R^2).

The standardised incidence rate of T2DM by age was calculated by the direct standardisation method. The essence of the direct method consists in calculating the general intensive indicators in the populations of the same composition, for which we calculated the particular indicators in the compared regions, which were used to judge their true ratio in the studied populations. The average age composition of the population of administrative-territorial entity was taken as the standard. The age structure of the population of Azerbaijan was used as the age standard (0-14 years old 22.3%; 15-29 years old 27.5%; 30-44 years old 21.9%; 45-59 years old 19.2%; 60 years old and older 9.1%). The variability of the incidence rate of the population with T2DM was assessed by the following criteria:

– fluctuation interval (the difference between the highest and lowest incidence rates by years);

– average five-year incidence rate in cities;

– volatility of the incidence rate (the size of the standard deviation).

Statistical processing was carried out using the "data analysis" package of the Excel software, methods of analysis of qualitative characteristics were used [35].

RESULTS AND DISCUSSION

Data on the incidence of T2DM in the cities of Azerbaijan are shown in Table 1.

Table 1. The incidence rate of the population of T2DM in the cities of the Republic of Azerbaijan (per 100 thousand population)

Cities of republican subordination	2012	2013	2014	2015	2016	2012–2016
Baku	262.7±3.4	272.2±3.5	320.7±3.5	345.1±3.8	340.7±3.9	308.3±3.7 (38.5)
Sumgayit	148.9±6.7	165.5±7.0	187.7±7.5	227.4±8.2	304.0±9.5	206.7±7.8 (61.8)
Ganja	89.5±5.2	214.6±8.0	264.3±8.9	270.1±9.1	280.5±9.2	223.8±8.2 (79.2)
Mingachevir	172.2±13.0	198.8±13.9	146.6±12.0	112.2±10.5	90.6±9.4	144.0±11.9 (43.8)
Shirvan	166.4±14.1	115.8±11.8	167.6±14.2	229.1±16.6	243.6±17.1	184.6±14.9 (52.0)
Naftalan	546.3±74.8	597.9±78.2	278.4±78.2	154.6±53.5	402.0±39.9	395.8±63.8 (184.0)

In 2012, the highest incidence rate of T2DM among the population was in Naftalan ($546.3\pm74.8^{0}/_{0000}$) and the lowest in the city of Ganja ($89.5\pm5.2^{0}/_{0000}$). A pairwise comparison between the cities of Sumgayit ($148.9\pm6.7^{0}/_{0000}$), Shirvan ($166.4\pm14.1^{0}/_{0000}$) and Mingachevir ($172.2\pm13.0^{0}/_{0000}$) does not reveal a statistically significant difference in the incidence rate ($p > 0.05$). In these cities, the incidence probability is significantly ($p < 0.01$) higher than in Ganja ($89.5\pm5.2^{0}/_{0000}$), less than in Baku ($262.7\pm3.4^{0}/_{0000}$) and Naftalan ($546.3\pm74.8^{0}/_{0000}$). The volatility of the incidence rate is high (standard deviation – 151.3). The difference between cities in the standardised level of T2DM morbidity ($235^{0}/_{0000}$ in Baku, $154^{0}/_{0000}$ in Sumgayit, $80^{0}/_{0000}$ in Ganja, $170^{0}/_{0000}$ in Mingachevir, $165^{0}/_{0000}$ in Shirvan and $512^{0}/_{0000}$ in Naftalan) remains. At the same time, the volatility of the standardised incidence rate of T2DM (151.6) did not differ from that for the actual incidence rate (151.3).

The change in the incidence rate (I) of T2DM in the city of Baku for 2012-2016 (x) was significant in 2014 and 2015. The main trend of the dynamics is the upward trend, which is described by the following linear regression equation ($I=22.884x+239.64$; $R^2=0.8816$). The volatility of the incidence rate of the T2DM in Baku city over five years is relatively low (standard deviation 38.5). In Sumgayit, the dynamics of the incidence rate was more intense for 5 years, there is a doubling of the indicator ($148.9\pm6.7^{0}/_{0000}$ in 2012, $304.0\pm9.5^{0}/_{0000}$ in 2016). The linear equation describing the main trend ($I=37.188x+95.164$; $R^2=0.9051$) of the dynamics has a high approximation and the volatility of the indicator (61.8) is much higher than in the city of Baku. In Ganja, where the lowest level of T2DM incidence was observed in 2012, the indicator increased more than 2 times in 2013 (214.6) and the growth trend continues until 2016 ($280.5\pm9.2^{0}/_{0000}$). The linear equation describing the growth trend has a high accuracy ($I=43.727x+92.631$; $R^2=0.7616$). The volatility (79.7) of the incidence rate is

2 times higher than in Baku and closer to the data of Sumgayit.

In the city of Mingachevir, the incidence of T2DM in 2012 and 2013 does not differ significantly from each other ($172.2±13.0^0/_{0000}$ and $198.8±13.9^0/_{0000}$; $p>0.05$), in subsequent years the indicator is dynamically significantly decreasing and in 2016 it was $90.6±9.4^0/_{0000}$. The regression equation ($I=-25x+219.09$; $R^2=0.8141$), which describes the trend of the decline in incidence, has a good approximation. The volatility of the T2DM incidence rate for 2012-2016 (43.8) in Mingachevir is less than in Sumgayit and Ganja, closer to the indicator in Baku.

In Shirvan, the incidence rate of T2DM in comparison with the previous year decreased in 2013 and increased in 2014, 2015 and 2016. The main trend in the change of the incidence probability is the growth trend, the regression equation ($I=26.779x+104.22$; $R^2=0.6624$) describes the linearity of the dynamics with a relatively lower accuracy (66%). The volatility of the incidence rate of T2DM in 2012-2016 is 52, closer to the indicator of the cities of Sumgayit and Mingachevir.

In Naftalan, where the incidence rate of T2DM was the highest in 2012, the indicator is changing chaotically. In 2015, the incidence rate was 3 times less than in 2012. The linear regression equation ($I=-73.198x+615.46$) has a weak approximation ($R^2=0.3953$). The polynomial equation ($I=61.856x^3–514.73x^2+1134.8x–129.9$) describes the trend line with high accuracy ($R^2=0.9838$) and shows the wavy line. The volatility of the incidence rate of the population with T2DM (184) is more pronounced compared to Baku (up to 5 times), Sumgayit (3 times), Ganja (more than 2 times), Mingachevir (up to 4 times) and Shirvan (more than 3 times).

The incidence rate of the T2DM population in the cities of Azerbaijan (five-year average $144.0±11.9$-$395.8±63.8^0/_{0000}$) is relatively higher than the data in Korea [1], India [3] and Canada [2]. It is obvious that the urban population of Azerbaijan is characterised by a high risk of T2DM. At the same time, attention is drawn to the severity of the difference in the level of actual and age-standardised morbidity in the population of cities of different types, which manifests itself in several forms. First, the interval between the highest and lowest incidence rates by calendar years is variable ($456^0/_{0000}$ in 2012, $174^0/_{0000}$ in 2014). Secondly, the trend and rate of change in the incidence rate over time are not the same. In Mingachevir, the incidence tends to decrease, in Baku, Sumgayit and Ganja, the incidence is increasing in dynamics, in Shirvan and Naftalan the indicator changes chaotically. This suggests that the annual incidence rates of the population with T2DM cannot be adequately used for the probabilistic assessment of the risk of T2DM. In this regard, average chronological incidence rates may be more adequate. According to our data, with a significant difference in the annual incidence of T2DM in the cities of Sumgayit, Ganja and Shirvan, the five-year chronologically average level of the indicator does not differ significantly from each other ($206.7±7.8^0/_{0000}$; $223.8±8.2^0/_{0000}$ and $184.6±14.9^0/_{0000}$). Taking into account the noted for the characterisation of the variability of the risk of morbidity, the standard deviation, which is considered a criterion of volatility, can be used as a volatility criterion. The incidence of diabetes mellitus is more volatile in Naftalan, relatively less volatile in Ganja, Sumgayit, Mingachevir and Shirvan, the lowest volatility is typical for Baku.

The difference in the incidence rate of the T1DM population between the cities of Azerbaijan cannot be explained by the unequal age composition of the population, since the age structure of the urban population does not differ sharply from each other and when calculating the standardised incidence rates, the difference between cities does not decrease. The inequality of cities in the probability of the incidence of DM2 population has deeper reasons, the clarification of which requires additional research.

CONCLUSIONS

1. The risk of incidence of type II diabetes mellitus in the cities of Azerbaijan differs significantly from each other, both in terms of actual and standardised coefficients.

2. The variability of the incidence rate of the population with type II diabetes mellitus in cities is more pronounced in its annual coefficients than in average chronological coefficients and standard deviations.

3. The volatility of the risk of the incidence of type II diabetes mellitus can be comprehensively assessed by the

level of annual, chronological average incidence rates, the interval of their fluctuations and the size of the standard deviation.

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Conflict of interest

The authors declare no conflict of interest.

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