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Анализ эпидемиологических показателей сахарного диабета 2 типа среди взрослого населения города Москвы

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Сахарный диабет (СД) – заболевание, которое представляет глобальную медицинскую проблему. При планировании и организации оказания специализированной медицинской помощи больным СД 2 типа (СД2) необходимо проведение углубленного анализа эпидемиологической ситуации.

Цель. *Оценка основных эпидемиологических показателей СД2 в условиях «реальной клинической практики» на* ***основании информационной базы данных Государственного регистра больных сахарным диабетом.***

Материалы и методы. *Эпидемиологический анализ проведен по двум административным округам города Москвы, в которых к 2011 г. по обращаемости за 12 лет было зарегистрировано 48 978 взрослых больных в возрасте от 18 лет и старше (сплошная выборка) с диагнозом СД2. Использованы методы клинической, аналитической и статистической эпидемиологии с элементами описательного эпидемиологического исследования.*

Результаты. *Распространенность СД2 составила 1590 на 100 тыс. населения, наибольшее количество больных выявлено в возрастных группах 60–64 лет и 70–74 лет, около 80% пациентов были старше 55 лет. Заболеваемость СД2 составила 138,72 на 100 тыс. населения, причем в 1,89 раз выше среди женщин. Летальность взрослых больных СД2 составила 0,83%, большая часть среди мужчин всех возрастов. На долю сердечно-сосудистых заболеваний приходилось большинство зарегистрированных случаев летальных исходов (34,4%). Средняя продолжительность жизни составила 75,24±0,45 лет, у женщин – на 6 лет больше, чем у мужчин. Средняя длительность заболевания – 10,04±0,34 лет. Стационарное лечение прошли 0,4% пациентов, средняя длительность пребывания в стационаре – 17–18 дней. Суммарное число дней нетрудоспособности составило в среднем 307,33±30,13 (80% пациентов были старше 55 лет). В исследуемой группе средний уровень HbA_{1c}<7% наблюдался у 56,6% пациентов. Распространенность выявленных хронических осложнений оказалась значительно ниже по сравнению с аналогичными показателями, полученными в контрольных эпидемиологических исследованиях.*

Заключение. *Проведенный эпидемиологический анализ выявил ряд особенностей и закономерностей в зависимости от половозрастных показателей. Для предотвращения и снижения частоты развития хронических осложнений СД необходимо реформирование системы здравоохранения РФ и выделение дополнительных финансовых средств, направленное на организацию повсеместного скрининга по раннему выявлению осложнений СД и проведению своевременного лечения.*

Ключевые слова: *сахарный диабет; эпидемиология; распространенность; заболеваемость; смертность; Москва; реальная клиническая практика; регистр; продолжительность жизни; осложнения*

Analysis of epidemiological indices of type 2 diabetes mellitus in the adult population of Moscow

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Diabetes mellitus is a disease that presents a global medical problem. It is necessary to implement an in-depth analysis of the epidemiological situation of type 2 diabetes mellitus for planning and organizing specialized medical help to patients with type 2 diabetes mellitus.

Aim. *To rate the basic epidemiological indices of type 2 diabetes mellitus in actual clinical practice using the informational database of national registry of diabetic patients.*

Materials and methods. *Epidemiological analyses were performed in two administrative districts of Moscow. From 1999 to 2011 48978 adult patients with type 2 diabetes mellitus who were aged 18 years and older were registered. We used methods of clinical, analytical and statistical epidemiology with elements of descriptive research.*

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Results. *The prevalence rate of type 2 diabetes mellitus was 1590 per hundred thousand, most patients were in the 60–64 and 70–74 age groups, and approximately 80% of patients were older than 55 years. The morbidity rate of type 2 diabetes mellitus was 138,72 per hundred thousand and was found to be higher in women at 1,89. The mortality rate of adult patients with diabetes mellitus was 0,83, mostly in men of all ages. Cardiovascular diseases accounted for most of the registered cases of deaths (34,4%). The average life expectancy appeared to be 75,24±0,45 years, although women lived 6 years longer than men. The average duration of the disease was 10,04±0,34 years. A total of 0,4% of patients underwent hospital treatment and the average length of treatment was 17–18 days. The total number of days of disablement was an average of 307,33±30,13 days (80% of patients were older than 55 years). In the study group, a mean grade of HbA_{1c}<7% was observed in 56,6% of patients. The prevalence rate of detected chronic complications was considerably lower compared to other epidemiological studies.*

Conclusions. *Our epidemiological analyses revealed a number of features and consistent patterns dependent on sex and age indices. It is necessary to reform the system of health services of the Russian Federation and to assign some additional funding directed towards organising ubiquitous screening for early detection of complications of diabetes mellitus and timely treatment to prevent and lower the frequency of chronic complications of diabetes mellitus.*

Keywords: *diabetes mellitus; epidemiology; prevalence rate; morbidity rate; mortality rate; Moscow; actual clinical practice; register for average life expectancy; complications*

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Diabetes mellitus (DM) is a non-infectious chronic disease that is a global health problem, posing a threat to public health.

The prevalence of type 2 DM (T2DM) is increasing dramatically. In 2000, the number of DM patients in the world was 171 million (2.8%); in 2013, it was 382 million people; and by 2035, experts from the International Diabetes Federation (IDF) predict a 55% increase in the number of DM patients, reaching up to 592 million [1].

On 7 October 1996, the Government of the Russian Federation approved the Federal target program 'Diabetes mellitus'. One section of the program was devoted to the development and management of the State Diabetes Registry (SDR). By 2002, under this program and in accordance with the order of the Russian Ministry of Health (No. 404, 10.12.1996), it was completed. The SDR is a unified automated information analysis system for monitoring the epidemiological status in the country with regard to prevalence of DM, its complications, the health status of patients and the quality of preventive and curative care as well as predicting health, social and economic aspects of the disease [2]. Patients are monitored from the time of DM diagnosis until the time of death [3].

In Russia, according to the SDR, as of 31 December 2012, the total number of DM patients registered by attendance, including children and adolescents with T1DM and T2DM, was 3,779,423, of which 3,453,680 (91.38%) had T2DM [2].

At the same time, control and epidemiological studies conducted in large regions of the Russian Federation have demonstrated that the actual prevalence of the disease in this country is 3–4 times higher than the officially registered numbers, according to the IDF, amounting to 10.9 million people (approximately 6%–7% of the adult population) [1].

Over the past 12 years, the total number of T2DM patients in the adult population of Russia has increased by 40.7%, with a calculated average annual growth rate of 6.23% [2, 4]. The highest prevalence is observed in the adult population of large cities. T2DM is more frequently detected in the female population of Russia [5].

According to the IDF, the vast majority of patients with T2DM are in the age group of 40 to 59 years worldwide and 30 to 50 years in the Russian Federation [1, 2]. Therefore, the majority of affected individuals are of working age.

The results of economic calculations acquired from official sources indicate that the direct costs for providing medical care to DM patients will increase each year against the backdrop of the constantly growing prevalence of the disease. An increase in the frequency of chronic complications of DM, particularly cardiovascular and renal diseases, changes in therapeutic approaches to treatment and broad implementation of new medical technologies and drugs also contribute significantly to an increase in total costs [6].

In-depth epidemiological analysis at the municipal district level is important to identify trends in the prevalence of T2DM and its complications, to plan specialised care for patients, to provide drugs and to promote other means of controlling carbohydrate metabolism, e.g. lifestyle changes. The results of these epidemiological studies are necessary to conduct modern pharmacoeconomic and pharma-

coepidemiological studies, with simulations based on the actual epidemiological situation in the Russian Federation.

Aim and main objectives of the study

the aim of this study was to identify the main epidemiological indicators of T2DM under actual clinical practice conditions on the basis of the information database of the SDR in residents of the South and South–Western Administrative Districts of Moscow in 2011.

The main objectives of the study were as follows:

- to calculate the prevalence and incidence of T2DM;
- to estimate the mortality rate in patients in the study sample and to analyse the immediate causes of death in T2DM patients depending on gender and age;
- to calculate the mean life span and life span since disease onset (years) in adult T2DM patients by gender;
- to identify the prevalence of acute and chronic complications of T2DM in males and females;
- to compare the SDR indicators in the study patients with data on the actual prevalence of complications of T2DM obtained in controlled epidemiological (screening) studies within the Mobile Diabetes Centre project and the prospective observational non-interventional study DIA CONTROL as well as with the published SDR epidemiological data for the Russian Federation as a whole for 2012 [2, 5].

Materials and methods

epidemiological analysis was conducted using the anonymous database of the SDR of the South and South–Western Administrative Districts of Moscow (requirements of the federal law on personal data No. 152, 27.07.2006). The database included 48,978 adult T2DM patients who were registered during the 12 years up to 2011.

The study cohort included a continuous sample of all patients aged 18 years and older diagnosed with T2DM.

The prevalence, incidence and mortality rates for T2DM in the study sample were calculated, and the immediate causes of death depending on gender and age were analysed.

The mean life span and disease duration (number of years since the patient was registered before 2011) and the mean length of hospital stay were calculated, and the number of patients who underwent in-patient assessment and the treatment used were recorded.

The total number of disability days and the percentage of T2DM patients assigned to a disability group were analysed.

We conducted comparative analysis of the prevalence of acute and chronic complications of T2DM in the study patients with the published SDR data on the prevalence of T2DM complications for all adult patients living in the Russian Federation in 2012 (3,453,680 patients) [2]. The calculated parameters for the study patients were compared with the results of a prospective observational non-interventional study, DIA CONTROL, conducted in 2010–2011 in 10 regions of the Russian Federation (9,844 patients) [2].

In addition, the prevalence of T2DM complications in the study patients was compared with the actual prevalence of T2DM complications determined by controlled epidemiological studies. As part of the 'Mobile Diabetes Centre' project, all patients enrolled in the 'Screening for Diabetes Mellitus Complications' project were examined by leading experts from the Endocrinology Research Centre (ERC) during 2002–2007 in 20 regions of the Russian Federation (4,346 T2DM patients) [5] and during 2007–2011 in 23 regions of the Russian Federation (3,678 T2DM patients) [7]. The examination program was developed at ERC and implemented under the guidance of Academician I.I. Dedov and Professor M.V. Shestakova. The scientific director of the project was Professor Yu.I. Suntsov.

This study of the epidemiological features of T2DM in the urban population used clinical, analytical and statistical epidemiology methods with elements of a descriptive epidemiological analysis and special statistical methods for data processing (grouping data, measuring incidence and prevalence and producing graphical displays of the data). Data are presented as mean ± standard error of the mean (SEM).

Results

in total, 48,978 adult T2DM patients, including 34,363 females (70.16%) and 14,615 males (29.84%), were registered in the SDR for the South and South–Western Administrative Districts by 2011. According to the Moscow City Statistics Service, the population of the 2 districts of Moscow in 2011 was 3,080,300 [8].

The prevalence rate of T2DM (total number of patients registered by the end of 2011) was 1,590 per

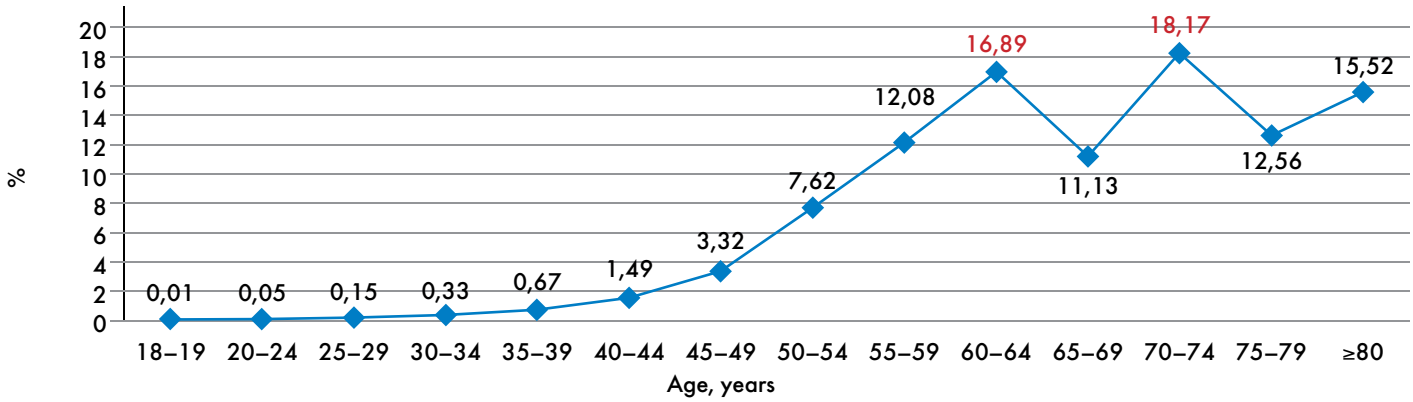

Fig. 1. Age-dependent prevalence of T2DM (%).

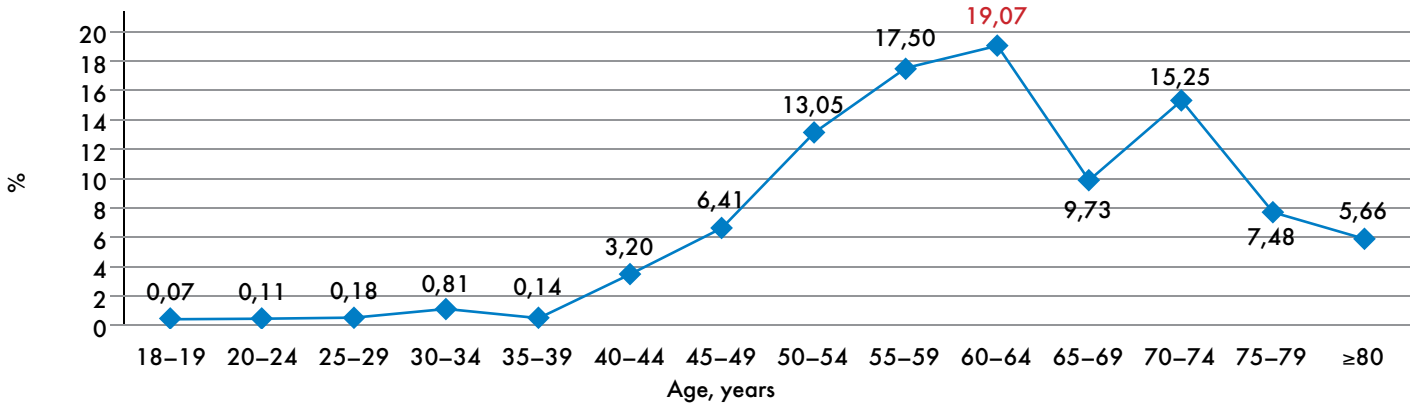

Fig. 2. Age-dependent incidence of T2DM in adults per 100,000 persons (%).

100,000 persons. The highest numbers of patients belonged to the 60–64- (16.89%) and 70–74-year age groups (18.17%), and approximately 80% of patients were older than 55 years (Fig. 1).

The incidence rate of T2DM in the study patients (number of patients registered for the first time during a calendar year) was 138.72 per 100,000 persons; 4,273 people were newly diagnosed with T2DM during the study period. In 2011, the incidence in the study cohort was 1.89-times higher in females (2,793, 65.36%) than in males (1,480, 34.64%). The incidence by age increased from 40 years and reached a peak of 19.07% at 60–64 years of age (Fig. 2).

According to the official statistical data for the study period published on the Moscow City Statistics Service website [8], the overall incidence rate of T1DM and T2DM in all residents of the capital in 2011 was 223.1 per 100,000 persons.

The mortality rate of adult T2DM patients (as a percentage of the total number of DM patients who died during the reference year) was estimated by the number of patients removed from the registry. The mortality rate was 0.83% (0.99% for males and 0.76% for females). The mortality rate was up to 2-fold higher for males of all age groups.

Analysis of ***the immediate causes of death*** of patients registered in the SDR database revealed the following patterns. In 2011, cardiovascular diseases accounted for the majority of reported cases of death, including chronic heart failure (CHF; 24.69%), myocardial infarction (MI; 7.9%) and acute cerebrovascular accident (ACVA; 7.9%) (Table 1). Hypoglycaemic coma, end-stage chronic renal disease and gangrene complicated by sepsis were identified as the cause of death in only 0.75% of patients in the study cohort. However, in most cases (57.04%), the causes of death were not differentiated and were designated as 'other'.

The leading causes of death, CHF, MI and ACVA, were more common among females (Fig. 3).

Table 1

Immediate causes of death in adult T2DM patients (% of deaths in the reference year)

Causes of death	Number of patients, people	%
Hypoglycaemic coma	1	0.25
Chronic renal insufficiency	1	0.25
Chronic heart failure	101	24.94
Myocardial infarction	32	7.90
Cerebrovascular disease	33	8.15
Gangrene complicated by sepsis	1	0.25
Other causes of death	236	57.04
Total of patients	405	100

According to the SDR, diseases contributing groups.

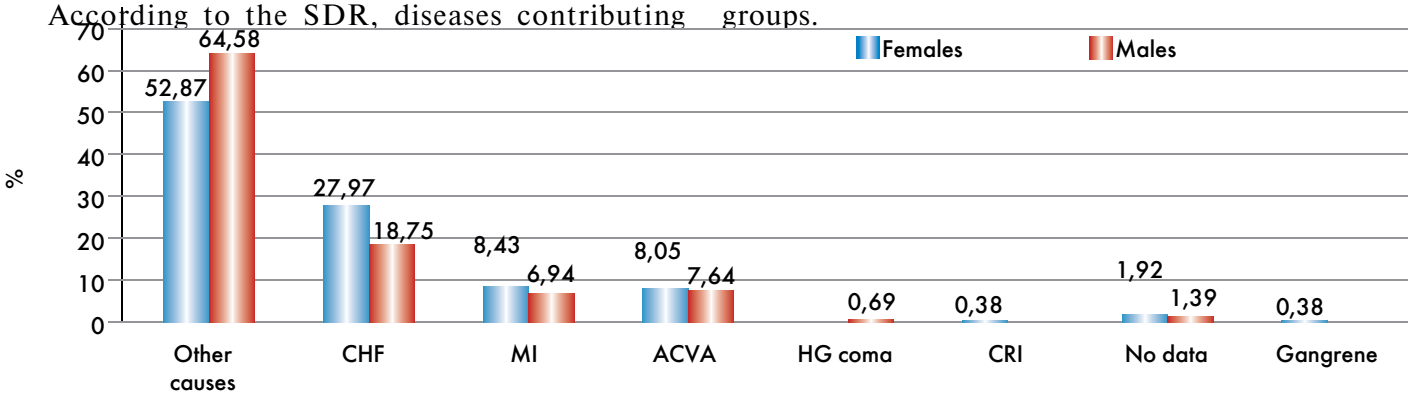

Fig. 3. Immediate causes of death in males and females with T2DM (% of deaths in 2011)
Notes: CHF, chronic heart failure; MI, myocardial infarction; ACVA, acute cerebrovascular accident; HG coma, hypoglycaemic coma; CRI, chronic renal insufficiency.

to death included coronary heart disease (CHD; 22% and 26.1% in males and females, respectively), chronic lung diseases (6% and 13.54% in males and females, respectively), acute infectious diseases (0% and 0.35% in males and females, respectively) and malignant neoplasms (5.33% and 3.82% in males and females, respectively).

The reported immediate causes of death in T2DM patients by age and gender are presented in Table 2. In the study sample, only 1 case of death from hypoglycaemia was reported in a 48-year-old male, and no case of death from diabetic ketoacidosis was reported. One case of death from chronic renal failure in an 83-year-old female and 1 case of death from gangrene complicated by sepsis in a 55-year-old female were reported.

Among patients who died from cardiovascular diseases, ***CHF*** was the most common cause of death.

The highest overall mortality from CHF occurred in the 55–59-year age group; however, the rate increased in males aged 60–64 years (31.6%), decreasing to 13%–19% in older age groups. The mortality rate in females aged 60–70 years decreased to 10%–15% but increased to 30% in the >80-year age group.

The highest mortality from ***MI*** in males occurred in the 50–54- (20%) and 55–59-year age groups (16.7%). In females, the first death from MI occurred in the 60–64-year age group, with the highest mortality rate in the 75–79-year age group.

For males, the rate of mortality from ***ICVA*** in the 60–64-year age group was 10.53%, remaining at 6.5% from 65–74 years and reaching a maximum in the oldest age group (>80 years). In females, ICVA was a frequent cause of death in the 55–59- (20%) and 65–69-year age groups (18.18%); however, the ICVA mortality rate decreased in the older age

The ***mean life span*** of study patients (estimated by the number and age of deregistered patients) was 75.24 ± 0.45 years. The life span of females was 6 years longer than that of males.

The disease duration (the number of life years from the disease onset to the time of the study) was 10.04 ± 0.34 years.

Most patients in 2011 were managed as outpatients; however, 210 people (0.4%) received inpatient treatment, which amounted to a total of 3,711

Table 2

Causes of disability in adult DM patients by age and gender (% of the number of disabled patients)

Gender	Disability cause	Age groups (generalised), adults	
		Abs.	%
Male	Diabetes mellitus	390	7.74
	Myocardial infarction	206	4.09
	Stroke	112	2.22
	Lack of vision	24	0.48
	Nephropathy	12	0.24
	Limb amputation	27	0.54
	Vascular diseases	934	18.55
	Other diseases	2464	48.93
	Cerebrovascular disease	12	0.24
	No data	855	16.98
	Total	5036	100
Female	Diabetes mellitus	953	6.2
	Myocardial infarction	229	1.51
	Stroke	208	1.37
	Lack of vision	43	0,28
	Nephropathy	21	0.14
	Limb amputation	13	0.09
	Vascular diseases	3041	20.05
	Other diseases	7954	52.46
	Cerebrovascular disease	28	0.18
	No data	2672	17.62
	Total	15162	100

Table 3

Prevalence of reported complications and concomitant diseases in T2DM patients by gender (% of the total number of T2DM patients)

Indicator	Males, % (n = 14,615)	Females, % (n = 34,363)	Total, males and females, % (n = 48,978)	SRD data on the prevalence of T2DM complications in the Russian Federation for 2012, % [2]* (n = 3,453,680)	Epidemiological screening data on the prevalence of T2DM complications for 2011, % [2]* (n = 9,844)
Diabetic coma	0.01	0.01	0.01	0.12	-
Autonomic neuropathy	1.32	1.54	1.28	5.72	4.7
Diabetic neuropathy (reported in the 'complications' entry)	2.09	1.86	2.0	12.6	-
Diabetic neuropathy (with allowance for urinary protein analysis result)	12.7	13.5	13.1	12.6	40.62
Complications and diseases causing vision disorders					
Diabetic retinopathy	6.79	8.30	7.9	17.51	38.4
Non-proliferative stage	4.22	5.28	4.96	-	-
Preproliferative stage	0.83	1.07	1.00	-	-
Proliferative stage	0.44	0.56	0.52	-	-
Loss of vision due to retinopathy	0.06	0.05	0.05	0.20	-
Loss of vision due to cataract	0.08	0.13	0.12	0.42	13.8
Cataract	1.97	3.50	3.04	12.76	-
Complications causing lower limb disorders					
Diabetic polyneuropathy of the lower limbs	7.55	8.29	7.84	18.35	82.46
Diabetic macroangiopathy of the lower limbs	3.31	3.17	3.2	12.56	4.91
Diabetic foot syndrome	1.31	0.74	0.9	3.78	4.65
Ischaemic form	0.1	0.07	0.08	-	-
Neuropathic form	0.1	0.09	0.1	-	-
Mixed form	0.14	0.08	0.1	-	-
Without ulceration	0.08	0.03	0.04	-	-
With ulceration	0.07	0.06	0.06	-	-
Amputation (within the foot, but more than 1 finger)	0.28	0.09	0.15	0.31	0.7
Amputation (at the level of the lower leg and higher)	0.22	0.07	0.12	0.36	0.1
Cardiovascular diseases (CVD)					
Arterial hypertension	19.60	23.46	22.30	46.51	87.18
Angina pectoris	6.55	8.20	7.7	14.45	27.6
Myocardial infarction	3.99	1.95	2.28	3.84	-
Stroke	2.72	2.17	2.3	3.81	-
Total of CVD:	32.9	35.8	34.6	68.6	-
Other complications	7.20	7.88	7.7	-	-

Note. * – Data published not for all T2DM complications and complication stages.

bed days (***the mean length of hospital stay was 17–18 days***).

The total number of disability days was very significant at 307.33 ± 30.13 days overall: 334.86 ± 31.02 days for females and 268.80 ± 57.79 days for males.

A disability group was assigned to 43% of patients in the study sample. The first group was assigned to 2.78% of patients, the second group was assigned to 40.52% and the third group was assigned to 11.05%. In more than 50% of cases, 'other diseases' formed the basis for assigning a disability group, followed by cardiovascular diseases. In 7.74% of males and 6.29% of females, T2DM was the cause for assigning a disability group (Table 2).

The prevalence of acute complications during the study period was low. Diabetic coma was reported in 5 males and 4 females, accounting for less than 0.01% of the total number of complications.

The prevalence of SDR-reported acute and chronic complications of T2DM and concomitant diseases in 2011 in residents of the 2 districts of Moscow is presented in Table 3.

The prevalence of ***diabetic nephropathy*** was estimated by the number of cases reported in the SDR in the 'complications' category (only 2% of the reported complications). The calculated prevalence was based on the available SDR data on urinary protein analysis. According to the calculations, the

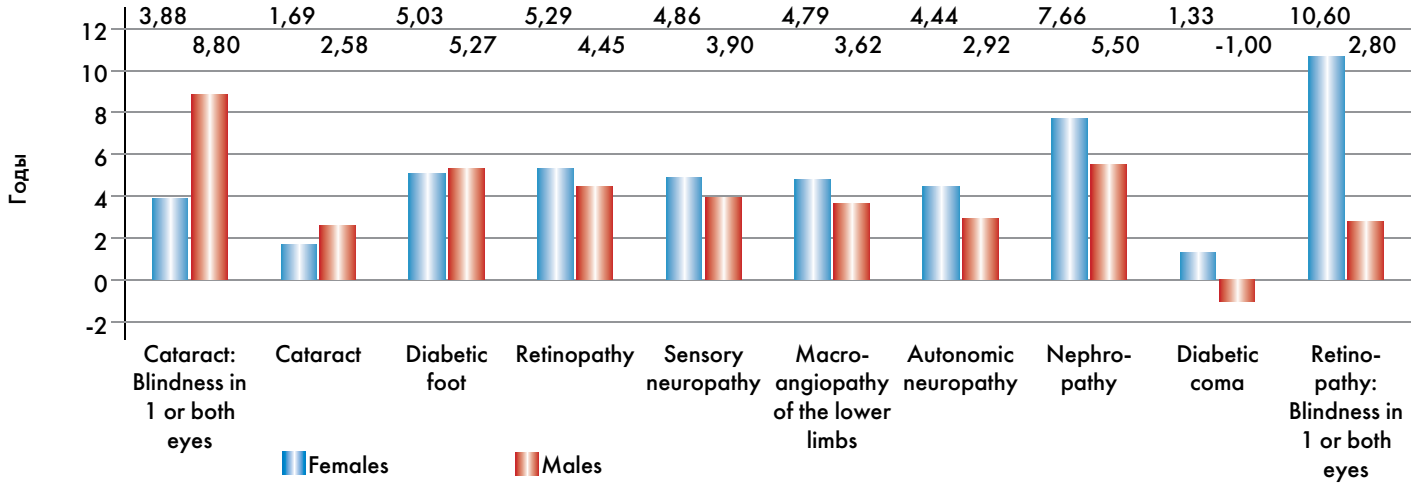

Fig. 4. The mean time from diagnosis to the development of complications in adult T2DM patients

prevalence of nephropathy in patients with urinary protein data was 13.1%.

Diabetic foot syndrome is a serious complication of diabetic neuropathy and macroangiopathy of the lower limb arteries. In the study patients, the incidence of this in males was twice that in females and the total number of amputations performed in males was 3-times higher than that in females.

Cardiovascular diseases (arterial hypertension, angina pectoris, MI and ACVA) were reported in 32.9% of males and 35.8% of females. According to the SDR, the prevalence of cardiovascular diseases in the study patients was 34.46%.

We calculated the mean time (in years) from the diagnosis of T2DM to the detection of certain chronic complications. The differences between males and females are presented in Fig. 4.

The following chronic T2DM complications were detected earlier in males than in females: retinopathy by 0.84 year, nephropathy by 2.16 years, sensory polyneuropathy by 0.96 year, autonomic neuropathy by 1.52 years and macroangiopathy of the lower limbs by 1.17 years. Notably, blindness in 1 or both eyes secondary to diabetic retinopathy developed approximately 8 years earlier in males than in females.

Females developed diabetic foot syndrome and cataract slightly earlier than males (by 0.24 and 0.89 years, respectively); however, the loss of vision secondary to cataract was diagnosed 5 years earlier, on average, in females than in males.

The level of glycosylated haemoglobin (HbA_{1c}) is an important indicator of the efficiency of carbohydrate metabolism control in patients with DM. In 2011, the HbA_{1c} level was >7% in 43.39% of study patients.

Discussion

analysis of the key epidemiological indicators of T2DM in residents of Moscow on the basis of data from the SDR revealed a number of interesting findings and patterns.

In the study patients, the prevalence of T2DM was 2.3-times higher in females than in males. This result corresponded to the SDR data for Russia as a whole in 2007, which identified a high prevalence (10%–12%) of T2DM in Russian females aged 60 years and older [5]. The trend toward a moderate predominance of females among T2DM patients has also been observed in other countries. However, some difference between males and females may be explained by the fact that females more frequently seek medical advice. Furthermore, females have a lower overall mortality and a longer life span than males. According to the 2010 Russian population census, the number of females exceeds the number of males by 894,000 [9].

The observed gaps in the indicators of the prevalence and incidence of T2DM in the 65–69- and 75–79-year age groups are associated with a significant deformity of the age–gender structure of the population of Russia (Fig. 5). The age structure of the population of Russia bears the imprint of both tragic events of the 20th century (famine and war) and the impact of crucial decisions on social and economic policy [9].

Recording the annual number of deaths and the causes of death (along with diseases and injuries suffered by living people) is the best way to assess the efficiency of a country's health system. Based on these data, public health authorities can determine whether their resources are being applied effectively and appropriately. For example, if mortality

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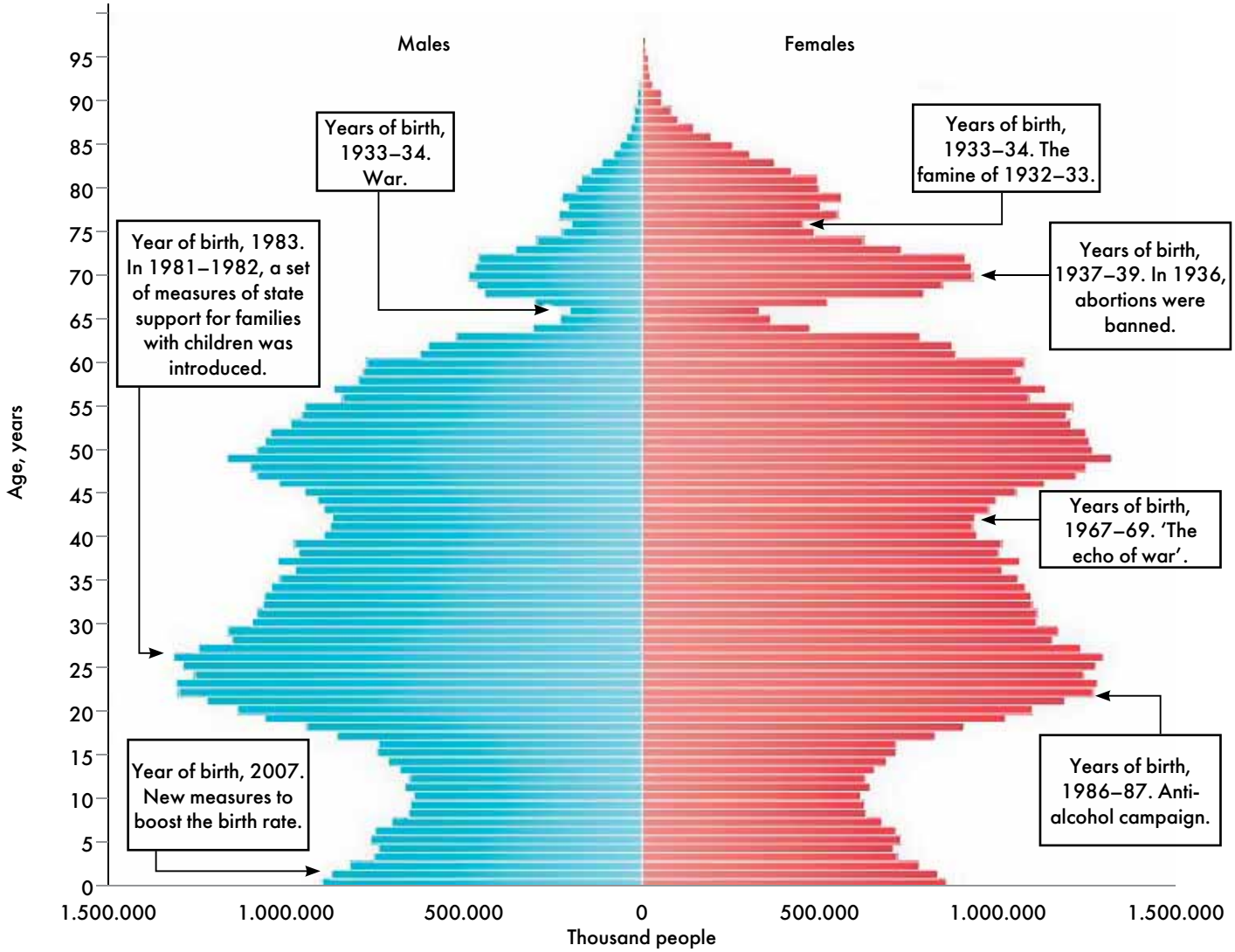

Fig. 5. The effect of various historical events on the age and gender structure of the population of Russia (population structure is given for the beginning of 2010) [9]

from heart disease or diabetes has increased rapidly, health authorities should aim to develop and promote intensive programs encouraging lifestyle changes to prevent these diseases [10].

The sample size of the present study did not allow the assessment of the true mortality rate (the number of patients who died per year per 100,000 persons); however, the mortality rate is an important tool to assess the efficiency of health care.

According to the fact sheet of the World Health Organization (WHO) No. 310 from July 2013 entitled 'The 10 leading causes of death in the world', an increasing number of people are dying from chronic diseases. In 2011, 1.4 million people died from DM worldwide (2.6% of total deaths) compared with 1.0 million people (1.9%) in 2000 [11]. The main diseases causing death over the previous decade were CHD (10.6%), cerebrovascular disease (11.2%), infections of the lower respiratory tract (6.7%), chronic obstructive pulmonary diseases (5.8%), diarrhoea (4.7%) and HIV/AIDS (3.1%). In the WHO fact sheet, 40.2% of deaths were classified as resulting from 'other causes'.

Prior to the creation of the SDR, Russia had no official statistics on the mortality of DM patients [2]. Registration of deceased patients in the SDR database has allowed tracking of the general trend in mortality from T2DM, which has decreased by 21.2% over the past 5 years. However, analysis of the data from most regions suggests that the records of deceased patients with DM are incomplete.

According to a study by Roshchin et al. published in 2012, a comparison of statistics on mortality from DM in the Russian Federation and other countries suggests that there is a significant under-reporting of deaths from DM in Russia [12].

According to Waisman, this under-reporting occurs because doctors do not always properly in-

terpret the primary cause of death in DM patients [13]. This is partly because of an incorrect translation of the International Classification of Diseases, 10th Revision (ICD-10) into the Russian language. A passage on page 75 of Volume 2 of the ICD-10 is as follows: 'Acute or terminal circulatory diseases reported as due to malignant neoplasm, diabetes or asthma should be accepted as possible sequences in Part I of the certificate'. The English primary source states 'should be accepted'; however, it should have been translated as 'must be accepted'.

This mistranslation means that when a patient dies of MI or ACVA associated with DM, doctors classify the primary cause of death as MI or ACVA but not DM. Consequently, mortality from DM has been underestimated, and mortality from circulatory diseases has been overestimated. The impact of this incorrect classification of the primary cause of death and the resultant differences in mortality from DM and circulatory diseases have been confirmed by international comparisons.

For example, in 2010, the mortality rate from DM in the Russian Federation was 5.4 per 100,000 population compared with 11.9 per 100,000 in Europe and 22.4 per 100,000 in the United States [14].

Therefore, different approaches to the classification of the primary cause of death in the Russian Federation and some other countries affect indicators of the population mortality structure [11].

Analysis of the immediate causes of death in the study patients demonstrated that cardiovascular diseases accounted for the majority of reported cases of death (34.4%) in 2011, being significantly more frequent in females.

At the same time, CHD (22% and 26.1% in males and females, respectively) was classified as a disease 'contributing to death'. In some cases, clinicians probably underestimated the important role of macroangiopathy in deaths among T2DM patients. This could explain the significantly lower percentage of cardiovascular complications as a leading cause of death in the study patients compared with the SDR data for other territorial regions of the Russian Federation.

Notably, in Russia, there is a large difference in the mortality and life span between males and females, including a male super-mortality in the working age group [9]. According to the 2010 population census, the life span in females was 12 years longer than that in males. The age-specific mortality rates in males of working age were 3–3.5-times higher than those in females. According to official reports, most deaths in this age group were from circulatory diseases (32.0% of deaths in males and 25.7% of deaths in females) and external causes [15].

The first most frequent cause of death from heart disease in the study patients was CHF (24.7%), followed by MI and ACVA (both 7.9%).

In particular, mortality from CHF was the leading cause of the overall mortality in T2DM patients. In the past, international studies have underestimated the significance of CHF as a cause of death in T2DM patients. Prof. John J. McMurray (University of Glasgow, Scotland), in his report at the European Congress of Endocrinology in 2013, stressed that 'Diabetes specialists in conjunction with cardiologists should take seriously the problem of CHF in T2DM patients. It is necessary to consider this nosology as one of the "endpoints" in clinical trials, and it was a big mistake that the previously published results of large international clinical studies on the outcomes of T2DM did not even mention one of very important, if not the most important, cardiovascular complications of DM—CHF'. [16]

An important economic indicator of a disease is the total number of disability days in the affected population. The amount of time off work for illness was extremely high in the T2DM patients in the present study (307.33 ± 30.13 days per year), and it was higher in females. This could be associated with the calculated prevalence rate of DM in the study patients by age group (more than 80% of DM patients were older than 55 years).

Most T2DM patients received specialised outpatient care during the reference year, while only 0.4% of patients required hospital treatment. This low percentage of patients requiring hospitalisation, as reflected in the SDR database, could be partly explained by an underestimation of the number of hospitalisations for DM per se, relative to concomitant disease, including cardiovascular disease.

Data on the prevalence and severity of disease complications are required to evaluate the efficiency of health systems and treatment and to calculate the costs of treatment for T2DM patients. Assessment of the efficiency of DM treatment includes the average time (in years) between disease onset and the development of complications. Because T2DM is often asymptomatic in its early stages, diagnosis may be delayed and chronic complications may already be present at the time of diagnosis.

The calculated data on the prevalence of nephropathy agreed with the 2012 SDR data for the Russian Federation as a whole.

However, the actual prevalence determined from regional controlled epidemiological studies was 3.1-times higher than the results obtained for the study group (Table 3) [2]. Notably, urinary protein analysis was only conducted in 18.9% of patients in the study sample. Diabetic nephropathy at the microalbuminuria stage was diagnosed in 10.79% of cases, at the proteinuria stage in 2.5% of cases and at the chronic renal failure stage in 0.01% of cases (3 patients underwent kidney transplantation). Controlled epidemiological studies suggest that the prevalence of microalbuminuria in the adult population with T2DM is approximately 35%, which agrees with the results of epidemiological studies of European T2DM patients [5].

Therefore, in the present study, diabetic nephropathy at different stages was detected in 13.3% of patients who underwent urinary protein analysis in 2011. However, nephropathy was only reported for 2% of patients in the 'complication' subsection of the SDR.

One possible explanation for inconsistency between the prevalence rate of diabetic nephropathy and similar parameters obtained in controlled epidemiological studies is that operators only add the clinical stages of this complication (proteinuria and chronic renal failure) to the SDR database. The preclinical stage of nephropathy, microalbuminuria, is not identified unless quantitative urinary protein analysis is performed.

Creatinine levels > 120 μmol/L were recorded in 1.77% of study patients (2.88% for males and 1.01% for females).

Data on the prevalence of diabetic retinopathy also differed significantly from the prevalence of 17.5% reported by the SDR for Russia as a whole in 2012 [2]. In the study patients, diabetic retinopathy was detected in 6.79% of males and 8.30% of females. The non-proliferative stage of retinopathy was diagnosed in 4.96% of patients, the preproliferative stage was diagnosed in 1.0% and the proliferative stage was diagnosed in 0.52%. Similar to nephropathy screening in residents of Moscow, this underestimation of the prevalence of diabetic retinopathy may also be a consequence of inadequate and delayed diagnosis of this chronic complication of DM, which can result in complete vision loss.

Controlled epidemiological studies conducted in 16 regions of the Russian Federation in 2011 revealed that the mean prevalence rate of diabetic retinopathy in adult T2DM patients was of 38.4%, which was 10% higher than the rate identified by the SDR [4]. In the epidemiological studies, 52% of patients were first diagnosed with retinopathy on screening examinations, and almost all had the non-proliferative stage of retinopathy [5].

The prevalence of diabetic cataract in the study patients was only 1.97% of males and 3.5% of females (3% overall), which was significantly lower than the prevalence for the Russian Federation as a whole (12.8%) and significantly lower than the prevalence reported in controlled epidemiological studies (30.9% for females and 27.45% for males).

Therefore, comparative analysis of data on the prevalence of diabetic nephropathy, retinopathy and diabetic cataract indicates an inadequate diagnosis of these T2DM complications, particularly in the initial stages.

Diseases of the lower limbs associated with T2DM include diabetic polyneuropathy, diabetic macroangiopathy of the lower limbs and diabetic foot syndrome. The prevalence of these complications according to the published SDR data for Russia was 2–3-times higher than the prevalence calculated for the study patients. This discrepancy could be because not all study patients underwent annual inspection at the 'Diabetic Foot' office. Therefore, the actual prevalence of diabetic foot syndrome is likely to be much higher than the reported prevalence.

However, data on the rate of amputation agreed well with data on the frequency of foot amputations (0.2%) and amputations at the level of the lower leg and higher (0.1%) obtained in controlled epidemiological studies [5].

According to the SDR data, the prevalence of cardiovascular diseases in the study patients (34.46%) was 2-times lower than the corresponding values for the Russian Federation as a whole (68.6%) [2]. The greatest differences were observed for arterial hypertension (22.3% and 46.1% for the study patients and Russia as a whole, respectively) and angina pectoris (7.7% and 14.45%, respectively). However, the frequencies of MI and ACVA in the study patients were comparable with the values for Russia as a whole [2].

The early diagnosis of CHD in T2DM patients is limited by the fact that CHD is often asymptomatic. In the SDR, the 'cardiovascular complications' entry contains the term 'angina pectoris', reflecting a clinically manifested form of CHD (7.7% in the study patients). T2DM patients at high risk of CHD, but without clinical signs of angina pectoris, need to pass a standard exercise test, which detects asymptomatic CHD in 32.4% of examined individuals [4]. Stress echocardiography increases the detection of asymptomatic CHD by 1.6 times compared with the standard exercise test. Therefore, more advanced methods should be used for detailed investigation of the cardiovascular system.

The use of advanced methods in T2DM patients with the absence of clinically evident CHD will detect CHD in 34%–51% of patients with 2 or more risk factors for this disease. Extensive use of this diagnostic algorithm, developed by the Department of Cardiology of the ERC to detect asymptomatic CHD and asymptomatic CHF, is necessary for doctors who treat T2DM patients [4].

According to the 'Algorithm of specialised care for patients with diabetes mellitus' approved in 2011, screening for microalbuminuria, fundus examination and examination of the lower limbs at the 'Diabetic Foot' office should be conducted in all DM patients at least once a year [13]. However, as discussed above, urinary protein analysis was performed in only 19% of patients in the study sample.

The prevalence of acute complications (diabetic and hypoglycaemic coma) during the study period was low (<0.01% of complications), which indirectly indicates a satisfactory state of diabetes care in the administrative districts of Moscow included in the study.

According to national and international standards of treatment, the target value of HbA_{1c} for adult T2DM patients is 7% [17]. In the study patients in 2011, HbA_{1c} was >7% in 43.39% of patients, which agrees well with the results of controlled epidemiological studies in which the HbA_{1c} level was >7% in 48% of T2DM patients [2, 5].

In general, the data on the target values of HbA_{1c} indicate effective control of hyperglycaemia by diabetologists in the studied districts of Moscow. According to international studies, in developed countries, ≥50% of T2DM patients have HbA_{1c} > 7%. Therefore, the significantly lower incidence of DM complications, particularly microvascular complications (nephropathy and retinopathy), reported in the SDR for Moscow than for Russia as a whole, may reflect better control of hyperglycaemia in DM patients in Moscow.

Conclusions

1. Analysis of key epidemiological indicators of T2DM under actual clinical practice conditions for residents of the city of Moscow on the basis of the SDR allowed the identification of the main trends and patterns of prevalence, incidence and mortality rates.
2. Study of the immediate causes of death demonstrated that CHF was the main cause of death from cardiovascular disease in T2DM patients. The findings agree with recent research, which has indicated that the primary role of CHF as a cause of death in T2DM patients has been underestimated.
3. The comparison of data on DM mortality between the Russian Federation and other countries suggested that there is a significant underestimation of deaths from DM in Russia. In particular, doctors do not always correctly interpret the primary cause of death, and this has affected indicators of the population mortality structure.
4. The prevalence of chronic complications detected in the study patients was many times lower than that detected in controlled epidemiological studies. To prevent the development of chronic DM complications and to preclude their rapid progression, it is necessary to reform the health care system of the Russian Federation and to provide additional funding aimed at organizing nationwide screening of the leading T2DM complications.
5. Further development and implementation of programs for the early detection of asymptomatic CHD and asymptomatic CHF are required to reduce the risk of cardiovascular mortality and to increase the life span of DM patients.
6. Further in-depth comparative epidemiological, pharmacoepidemiological and clinical and economic studies are required to comprehensively assess various aspects of T2DM, a non-infectious pandemic of the 21st century, and to plan and organise specialised care for DM patients, providing medicines and effective management of carbohydrate metabolism to control and prevent the development of complications.

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