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Correlation between the Social and Medical Factors and Diabetic Retinopathy of T2D Patients

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Abstract

Diabetic retinopathy (DR) is one of the impending complications of the diabetes mellitus (DM) which results in blindness and is the main reason of the eyesight impairment of the DM patients aged 25-74, and, therefore, needs a thorough studying and prediction. DR is the most frequent effect of universal diabetic microangiopathy with the unfavorable prognosis which nowadays is medical and social issue for many countries across the world. Epidemiological data regarding diabetic retinopathy in Ukraine and results of the correlation between the social and medical factors and diabetic retinopathy of T2D patients study are presented in the article. To prevent the development of DR and to provide it's timely diagnostics a number of systemic approaches shall be applied in Ukraine, such as: elaboration and approval of the national protocols for rendering the specialized medical care for the specialty of "endocrinology", the approval of the national action plan concerning the diabetes mellitus, creation of the center for analytics and prediction of efficiency of rendering the specialized medical care for DM patients, introduction of the new efficient models and programs of DR screening.

Keyword: Blindness; Diabetes mellitus type 2; Diabetic retinopathy; Diabetic retinopathy screening; Fundus oculi; Laser treatment

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Introduction

Diabetic Retinopathy (DR) is one of the impending complications of the Diabetes Mellitus (DM) which results in blindness and is the main reason of the eyesight impairment of the DM patients aged 25-74 [1], and, therefore, needs a thorough studying and prediction.

DR is the most frequent effect of universal diabetic microangiopathy with the unfavorable prognosis which nowadays is medical and social issue for many countries across the world. According to the International Diabetes Federation (IDF), the total degree of incidence of DR among DM patients within 2015-2019 was about 27%. The lowest incidence was in Europe: 20.6% and South-East Asia: 12.5%, and the highest in Africa: 33.8%, Middle East and North Africa : 33.8%, and the Western Pacific: 36.2% [2].

The incidence of DR grows with the diabetes duration. Within first 20 years of disease almost all type 1 DM patients and more than 60% of type 2 DM patients developed the retinopathy. Epidemiological Survey of DR (WESDR) confirmed those 3.6% younger patients (T1D) and 1.6% of elderly patients (T2D) lost their eyesight. In younger age group 86% of blindness was caused by DR. In elderly age group where other opthalmologic disorders were spread, one third of officially fixed blindness incidents was connected with DR. [3,4] in 2012 the consolidated meta-analysis of the separate subjects (n=22896) within 10 years, observations from 1980 to 2008 showed that 35.4% DM patients, including T1D patients and 25.2% T2D panties had the DR symptoms. Total incidence of Proliferative DR (PDR) was 7%, diabetic macular edema: 7% and eye-threatening DR: 12%.

The additional risk factors of DR development include the glycemic control level, type of diabetes (historically at T1D DR develops more frequently than with T2D), and presence or absence of the comorbide conditions, such as arterial hypertension, smoking, dyslipidemia, nephropathy, and pregnancy, [5,6] Currently, the stable tendency to the increase of DM incidence among the population is observed (predicted growth of DM incidence is as follows: from 463 mln. in 2019 to 700 mln. in 2045 due to the population growth, ageing, urbanization, reduction of physical activity and unfavorable dietary changes) [7]. In connection with this, considering the increase of DM incidence and improvement of the diagnostic possibilities, the increase of diagnosed DR is observed. The incidence of the eye sight loss after this complication also maintains a stable growing tendency. Total amount of people with the eyesight disorders and blindness falling on DR in 2015 according to MDF's predictions was 2015 and in 2020 this index should have grown up to 3.2 mln. [8]. As long as, according to the calculations, by 2045 700 mln. people in the world will suffer from DM which will constitute approximately10% of adult population of the planet, out of which 245mln. will suffer from hypertension and 77mln. from DR which is sight-threatening, this will have the destructive socio-economic consequences [9].

According to the statistical indexes of activity of endocrinologic services of Ukraine for 2002-2016 the tendency to the growth of diagnosed DR in Ukraine is observed from 121,938 cases in 2002 to 158,333 incidents in 2016. However, as a result of realization of two National Target-Oriented Programs "Diabetes Mellitus", the reduction of DR incidence was observed among teenagers from 656 in 2002 to 123 in 2016 [10].

Lately due to the introduction of the state register of DM patients in need of insulin therapy, the degree of incidence of the eyesight

loss among the patients receiving insulin became known. Thus, in 2018 the following amount of people suffering from blindness was recorded: 1,702 (T1D) and 5,370 (T2D), which amounted to 2.92 and 3.95 percent correspondingly from the total amount of patients with the diabetes and insulin therapy, while in 2019 the following amount of patients with blindness was fixed: 1,849 (T1D) and 6,266 (T2D), which amounted to 3.14 and 4.52 percent correspondingly and in 2020 1,936 (T1D) and 6,689 (T2D) which amounted to 3.19 and 4.59 percent correspondingly from the total amount of diabetic patients [10].

Unfortunately, the statistical data concerning all types of DM starting from 2017 when the related form of reporting was canceled have become unaccessible.

Since the data have not been collected as of now, we believe that the studies performed on the basis of Ukrainian Scientific and Practical Center for Endocrine Surgery Transplantation of Endocrine Organs and Tissues is very topical from the point of view of studying the dynamic of DR development in different groups.

Objective

To study the correlation between the social and medical factors and diabetic retinopathy of T2D patients.

Materials and Methods

2,264 T2D patients were involved in the study (1,186 men and 1,078 women) who received medical aid at Ukrainian Scientific and Practical Center for Endocrine Surgery, Transplantation of the Endocrine Organs and Tissues of the Ministry of Health care of Ukraine.

The patients were subdivided into groups according to the age (72 men and 26 women aged under 40, 201 men and 65 women aged 40-49, 382 mend and 290 women aged 50-59, 395 mend and 463 women aged 60-69, 125 men and 208 women aged 70-79, 11 men and 26 women aged 80 and more), from the DM duration from the moment of diagnostics (121 men and 82 women with DM diagnosed for the first time, 307 men and 235 women with DM duration 1-5 years, 348 men and 303 women with DM duration of 6-10 years, 203 men and 208 women with DM duration of 11-15 years, 125 men and 151 women with DM duration 16-20 years, 68 men and 87women with DM duration over 20 years, not included into the study 14 men and 12 women whose DM duration was impossible to establish, place of the patients residence (160 men and 164 women from villages, 1026 men and 914 women from the cities, social status of the patients (425 men and 711 women pensioners, 90 men and 77 women with disabilities, 271 men and 92 women unemployed of working age, 400 men and 198 women employed, 786 men and 880 women from the most vulnerable population (MVP, pensioners+disabled people+unemloyed people, BMI (147 men and 125 women with BMI 18.5-24.9 kg/m^2, 398 men and 281 women with BMI 25-29.9 kg/m^2, 325 men and 293 women with BMI 30-34.9 kg/m^2, 135 men and 160 women with BMI 35-39.9 kg/m^2, 53 men and 96 women with BMI over 40 kg/m^2, not included into the studying 4 men and 2 women with BMI less than 18.5 kg/m^2 due to the indexes toll low for the analysis, and 124 men and 121 women, whose BMI cannot be determined), level HbA1c (57 men and 30 women with HbA1c up to 6.0%, 185 men and 104 women with HbA1c 6.1-7.0%, 204 men and 174 women with HbA1c 7.1-8.0%, 209 men and 199 women HbA1c 8.1-9.0%, 190 men and 165 women with HbA1c 9.1-10.0%, 271 men and 340 women with HbA1c over 10.0%, not included into the studying 70 men and 66 whose level of HbA1c has not been determined for different reasons), DM complications and their combinations (163 men and 104 women with Miocardial Infarction (IM), 1,023 men and 974 without IM, 91 men and 107 women with the blood-stroke, 1,095 men and 971 women without the blood stroke, 448 men and 257 women with the diabetic foot disease (DFD), 738 men and 821 women without DFD, 32 men and 13 women with IM+blood-stroke, 98 men and 32 women with IM+DFD, 54 men and 32 women with blood-stroke+DFD, 20 men and 5 women with IM+DFD+blood-stroke, 645 men and 678 women without any macro-vascular events, 326 men and 318 women with the diabetic angiopahy of lower extremities (DAP), 860 men and 760 women without DAP, 953 men and 874 women with DDNP, 233 men and 204 women without DDNP, 246 men and 187 women with diabetic Distal Nephropathy (DNP), 940 men and 891 women without DNP, 257 men and 292 women with Diabetic Encephalopathy (DEP), 929 men and 786 without DEP, 654 men and 665 women with diabetic retinopathy (DRP), comorbidities (310 men and 240 women with dislipidemy, 876 men and 838 women without dislipidemy, 401 men and 439 women with Arterial Sclerosis of Head and Neck (ASHN), 785 men and 639 without ASHN, 358 mend and 285 women with the Arterial Sclerosis of Lower Extremities (ASLE), 828 men and 793 women without ASLEK, 200 men and 178 women with ASHN+ASLE, 621 men and 528 women without atherosclerosis of peripheric vessels, 986 men and 944 women with Cardio-Vascular Diseases (CVD), 200 men and 134 women without CVD, 865 men and 862 women with Arterial Hypertension (AH), 321 men and 216 women without AH, 53 men and 95 women with oncological diseases, 1133 men and 983 women without oncological diseases, 392 men and 634 women with other endocrine diseases, 794 men and 444 women without other endocrine diseases, 508 men and 542 women with obesity, 561 men 421 without obesity.

Medical and social factors were studied with the application of the comparative data analysis. For statistical processing of data Statistika 10.0 (StatSoft) software was applied.

Results and Discussions

The study showed statistically higher frequency of DRP in all studied groups of women (61.69% vs.55.14% in all studied groups of men p=0,002) and women aged under 40 and 60-69, pensioners, with the DM duration of 11-15 years, cities, HbA1c 7.1-8.0%, 9.1-10.0% and over 10,0%, DDNP and women without IM, blood-stroke, DFD, macro-vascular events, ALE, DNP, DEP, dislipidemy, ASHN, ASLE, CVD, AH, oncological and other endocrinologic diseases and men aged 80 and more, with statistically the same indexes of men and women in other categories of patients Table 1.

Not determined statistical differences of the DRP incidence of patients of different sexes pensioners, disabled people, unemployed people, IM, blood-stroke, IM+DFD, blood-stroke+DFD, DEP, ASHN+ASLE, CVD, AH, oncological and other endocrinology diseases, obesity, and patients without IM, blood-stroke, ALE, DEP, dislipidemy, ASLE, atherosclerosis of peripheric vessels, AH, oncological and other endocrinology diseases, obesity; men depending upon BMI and level of HbA1c, employed people, with IM+blood-stroke, IM+DFD+blood-stroke, ASHN and men without ASHN; women depending upon the patients' age and place of residence, with DFD, ALE, DDNP, dislipidemia, and women without DFD, macro-vascular events, ALE and CVD.

Social and medical factors		Men	Women	p
Age of the patients	Under 40	24 (33.33)[1]	16(61.54)	<0.05, p=0.023
	40-49	104(51.74)	35(53.85)	p=0,768
	50-59	212(55.5)	178(61.38)	p=0,126
	60-69	233(58.99)	305(65.87)	<0.05, p=0.038
	70-79	75(60.0)	118(56.73)	p=0,558
	80 and more	6 (54.55)[2]	13(50.0)	<0.05, p=0,002
DM duration	f/d	40 (33.06)[3]	33 (40.24)[1]	p=0,295
	1-5	151(49.19)	130(55.32)	p=0,157
	6-10	202(58.05)	169(55.78)	p=0.56
	11-15	129 (63.55)[4]	152 (73.08)[2]	<0.05, p=0,038
	16-20	84 (67.2)[5]	112 (74.17)[3]	p=0.204
	Over 20	46 (67.65)[6]	62(71.26)	p=0.627
Place of the patients' residence	village	105 (65.63)[7]	103(62.8)	p=0.597
	City	549(53.51)	562(61.49)	<0.05, p=0,0004
Social status of the patients	Pensioners	242(56.94)	459(64.56)	<0.05, p=0.011
	disabled people	52(57.78)	46(59.74)	p=0,797
	unemployed	145(53.51)	53(57.61)	p=0,495
	employed	215(53.75)	107 (54.04)[4]	p=0,947
BMI	18.5-24.9 kg/m2	77(52.38)	76(60.8)	p=0.163
	25-29.9 kg/m2	225(56.53)	170(60.5)	p=0.302
	30-34.9 kg/m2	191(58.77)	201 (68.6)[5]	p=0.011
	35-39.9 kg/m2	76(59.3)	97(60.63)	p=0.452
	more than 40 kg/m2	35(66.04)	53(55.21)	p=0.198
HbA1c level	up to 6.0%	31(54.39)	13 (43.33)[6]	p=0.327
	6.1-7.0%	103(55.68)	51 (49.04)[7]	p=0.278
	7.1-8.0%	123(60.29)	123 (70.69)[8]	<0.05, p=0,035
	8.1-9.0%	121(57.89)	128(64.32)	p=0.183
	9.1-10.0%	107(56.32)	111(67.27)	<0.05, p=0,034
	more than 10.0%	148(54.61)	217(63.82)	<0.05, p=0,021
IM		95 (58.28)	59(56.73)	p=0.802
Without IM		559(54.64)	606(62.22)	<0.05, p=0,0002
Blood-stroke		54(59.34)	67(62.62)	p=0.637
Without blood-stroke		600(54.79)	598(61.59)	<0.05, p=0,002
DFD		290 (64.73)[8]	169(65.76)	p=0.783
Without DFD		364 (49.32)[9]	496(60.41)	<0.05, p=0,000
IM+blood-stroke		16(50.0)	10 (76.92)[9]	p=0.061
IM+DFD		59(60.2)	19(59.38)	p=0.934
Blood-stroke+DFD		35(64.81)	23(71.88)	p=0.662
IM+DFD+Blood-stroke		12(60.0)	5 (100.0)[10]	p=0.118
Without macro-vascular events		318 (49.3)[10]	421(62.09)	<0.05, p=0,000
ALE		211 (64.72)[11]	209(65.72)	p=0.79
Without ALE		443(51.51)	456(60.0)	<0.05, p=0,001
DDNP		566 (59.39)[12]	572(65.45)	<0.05, p=0,008
Without DDNP		88 (37.77)[13]	93 (45.59)[11]	p=0.098
DNP		178 (72.36)[14]	133 (71.12)[12]	p=0.777
Without DNP		476 (50.64)[15]	532(59.71)	<0.05, p=0,0001
DEP		150(58.37)	186(63.7)	p=0.201
Without DEP		504(54.25)	479(60.94)	<0.05, p=0,005
Dislipidemy		151 (48.71) 16	136(56.67)	p=0.064

Without the dislipidemy	503(57.42)	529(63.13)	<0.05, p=0,016
ASHN	223(55.36)	227 (61.5)[13]	p=0,257
Without ASHN	431(54.9)	438 (68.54)[14]	<0.05, p=0,000
ASLE	224 (62.57)[17]	197 (69.12)[15]	p=0,083
Without ASLE	430(51.93)	468(59.02)	<0.05, p=0,004
ASHN+ASLE	123(61.5)	121(67.98)	p=0,189
Without the atherosclerosis of peripheric vessels	354(57.0)	326(61.74)	p=0.104
CVD	580(58.82)	589(62.39)	p=0.109
Without CVD	74 (37.0)[18]	76(56.72)	<0.05, p=0,0004
AH	495(57.23)	530(61.48)	p=0.072
Without AH	159(49.53)	135(62.5)	<0.05, p=0,003
Oncological diseases	29(54.72)	53(55.79)	p=0.9
Without oncological diseases	625(55.16)	612(62.26)	<0.05, p=0,001
Other endocrine diseases	225(57.4)	385(60.73)	p=0.292
Without other endocrine diseases	429(54.03)	280(63.06)	<0.05, p=0,002
Obesity	302(60.04)	351(65.21)	p=0,076
Without obesity	302(53.83)	247(58.67)	p=0.131
All patients	654(55.14) [1]<0.05, p=0,0003 [2]<0.05, p=0,000 [3]<0.05, p=0,000 [4]<0.05, p=0,026 [5]<0.05, p=0.01 [6]<0.05, p=0,044 [7]<0.05, p=0,012 [8]<0.05, p=0,001 [9]<0.05, p=0,013 [10]<0.05, p=0,017 [11]<0.05, p=0,002 [12]<0.05, p=0,049 [13]<0.05, p=0,000 [14]<0.05, p=0,000 [15]<0.05, p=0,039 [16]<0.05, p=0,043 [17]<0.05, p=0,013 [18]<0.05, p=0,000	665(61.69) [1]<0.05, p=0.0001 [2]<0.05, p=0.002 [3]<0.05, p=0.003 [4]<0.05, p=0,043 [5]<0.05, p=0.03 [6]<0.05, p=0.042 [7]<0.05, p=0,012 [8]<0.05, p=0.023 [9]<0.05, p=0.001 [10]<0.05, p=0.003 [11]<0.05, p=0,000 [12]<0.05, p=0,014 [13]<0.05, p=0,0003 [14]<0.05, p=0,004 [15]<0.05, p=0,021	<0.05, p=0,002

Table 1: DRP incidence of T2D patients depending upon the social and medical factors, n (%).

However, the statistical differences of DRP incidence were established depending upon other social and medical factors, in particular, almost double growth of DRP incidence with the increase of DM duration. Noteworthy is the different level of impact on DRP incidence of the ALE and ASLE condition, for men - living in the rural areas, CVD, ALE, and DDNP, for women - BMI 30-34.9kg/m2, HbA1c 7.1-8.0%, IM+blood-stroke, IM+DFD+blood-stroke and absence of ASHN condition.

At the same time it was found that the development of DRP was accompanied by the statistically longer average duration of DM, incidence of DDNP, DNP and ASLE of the patients of different sex, higher average age of the patients, proportion of the village residents, average IM, incidence of DFD, CVD, and AH of men, higher proportion of MVP among women, but statistically lower incidence of dislipidemy of men and ASHN of women with the statistically similar indexes of the patients of different sexes concerning other studied indexes Table 2.

Index		**Men**	**Women**	**p**
Average age of the patients	DRP	58.59 ± 10.34	62.3 ± 9.47	<0.05, p=0,000
	without DRP	55.44 ± 11.6 <0.05, p=0,000001	62.19 ± 10.5	<0.05, p=0,000
	DRP	10.14 ± 7.31	11.88 ± 8.27	<0.05, p=0,0001
	without DRP	7.62 ± 6.93 <0.05, p=0,000	8.57 ± 7.43 <0.05, p=0,000	<0.05, p=0,043
Proportion of MVP, n (%)	DRP	439(67.13)	558(83.91)	<0.05, p=0,000
	without DRP	347(65.13)	322(77.97) <0.05, p=0,014	<0.05, p=0,000

Proportion of village residents, n (%)	DRP	105(16.06)	103(15.49)	p=0.778
	without DRP	55(10.34) <0.05, p=0,004	61(14.77)	<0.05, p=0,04
Average BMI, kg/m²	DRP	30.72 ± 5.4	31.48 ± 5.89	<0.05, p=0,02
	without DRP	29.93 ± 5.29 <0.05, p=0,017	31.93 ± 7.08	<0.05, p=0,000004
Incidence of IM, n (%)	DRP	95(14.53)	59(8.87)	<0.05, p=0,001
	without DRP	68(12.78)	45(10.9)	p=0.375
Incidence of blood-stroke, n (%)	DRP	54(8.26)	67(10.08)	p=0.253
	without DRP	37(6.95)	40(9.69)	p=0.128
Incidence of DFD, n (%)	DRP	290(44.34)	169(25.41)	<0.05, p=0,000
	without DRP	158(29.7) <0.05, p=0,000	88(21.31)	<0.05, p=0,004
Incidence of ALE, n (%)	DRP	211(32.26)	209 (31.43)	p=0.745
	without DRP	115(21.62) <0.05, p=0,000	109(29.39)	p=0.087
Incidence of DDNP, n (%)	DRP	566(86.54)	572(86.02)	p=0.78
	without DRP	387(72.74) <0.05, p=0,000	302(73.12) <0.05, p=0,000	p=0.897
Incidence of DNP, n (%)	DRP	178(27.22)	133(20.0)	<0.05, p=0,002
	without DRP	68(12.78) <0.05, p=0,000	54(13.08) <0.05, p=0,016	p=0.894
Incidence of DEP, n (%)	DRP	150(22.94)	186(28.0)	<0.05, p=0,036
	without DRP	107(20.11)	106(25.67)	<0.05, p=0,043
Incidence of dislipidemy, n (%)	DRP	151(23.09)	136(20.45)	p=0.246
	without DRP	159(29.89) <0.05, p=0,008	104(25.18)	p=0.109
Incidence of ASHN, n (%)	DRP	223(34.1)	227(34.14)	p=0,989
	without DRP	178(33.46)	212(51.33) <0.05, p=0,000	<0.05, p=0,000
Incidence of ASLE, n (%)	DRP	224(34.25)	197(29.62)	p=0.072
	without DRP	134(25.19) <0.05, p=0,001	88(21.31) <0.05, p=0,003	p=0.163
Incidence of CVD, n (%)	DRP	580(88.69)	589(88.57)	p=0.948
	without DRP	406(76.32) <0.05, p=0,000	355(85.96)	<0.05, p=0,0002
Incidence of AH, n (%)	DRP	495(75.69)	530(79.7)	p=0.08
	without DRP	370(69.55) <0.05, p=0,018	332(80.39)	<0.05, p=0,0002
Incidence of Oncological diseases, n (%)	DRP	29(4.43)	53(7.97)	<0.05, p=0,008
	without DRP	24(4.51)	42(10.17)	<0.05, p=0,001
Incidence of other endocrine diseases, n(%)	DRP	225(34.4)	385(57.89)	<0.05, p=0,000
	without DRP	167(31.39)	249(60.29)	<0.05, p=0,000
Incidence of obesity, n (%)	DRP	302(50.0)	351(58.7)	<0.05, p=0,003
	without DRP	206(44.3)	191(52.33)	<0.05, p=0,022

Table 2: Social and medical factors of T2D patients with DRP.

Note: P is the probability of differences of the inter-group comparisons as compared to the index of all patients without DRP

Conclusions

1. Social and medical factors had different level of impact upon the DRP incidence of T2D patients which shall be taken into account during patients management.
2. Every second T2D patients suffers from DRP and its development is accompanied by the differences between the social and medical factors, in particular, incidence of DDNP, DNP, and ASLE.
3. Substantial differences of DRP incidence and its impact on the studied factors depending upon the patients' sex which needs further studying, in particular, of the issues concerning the absence of statistic impact of DFD, DAP, DDNP and absence of ASHN upon the DRP incidence of women with different level of impact of such factors for men, and impact of IM+blood-stroke and IM+DFD+blood-stroke on DRP incidence for men with different level of impact of such factors for women.

4. Higher risk groups of DRP development:

For men – with substantial impact of DNP, DFD, and DAP, with moderate impact-DM duration for over 20 years and 16-20 years, residents of the villages, DM duration of 11-15 years, ASLE and DDNP%

For women – substantial impact of IM+DFD+blood-stroke, IM+blood-stroke, DM duration for 16-20 and 11-15 years, absence of ASHN, moderate impact-DNP, HbA1c 7.1-8.0%, ASLE and BMI 30-34.9 kg/m^2.

To prevent the development and to provide for the timely DR diagnostics a number of systemic approaches shall be applied in Ukraine, mainly: elaboration and approval of the national protocols for rendering the specialized medical aid in the specialty of "endocrinology", approve the national actions plan concerning the diabetes mellitus, create the center for analytics and prediction of the condition and efficiency of rendering the aid to DM patients, introduce the new efficient models and programs of DR screening [11].

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