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Clinical-Functional and Expert-Rehabilitation Parallels of Disability in the Adult Population Due to Diabetes Mellitus

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ABSTRACT

The area of "comprehensive rehabilitation" necessitates the development of rehabilitation programs tailored to specific nosological categories among patients with disabilities. Diabetes mellitus represents one of the most pressing issues in modern society. The effectiveness of rehabilitation measures and the improvement of patients' quality of life depend on the alignment of applied technologies with the severity of clinical and functional impairments, as well as their progression, which leads to varying degrees of activity limitations.

Objective To assess the degree of activity limitations in individuals with disabilities due to diabetes mellitus, based on their clinical and functional impairments.

Materials and Methods The study was compiled in Excel tables using the following methods: document analysis and data extraction (320 cases). The data prepared for analysis in .xlsx format were uploaded into the R environment. Data processing and analysis were performed using scripts in R. For continuous normally distributed variables, the mean and standard deviation were calculated; comparison between two groups employed the t-test. For continuous non-normally distributed variables, the mean (M) and standard deviation (SD) were calculated, and the p-value of the Student's t-test (p_t) was used to compare two groups. For non-normally distributed continuous variables, the median (Me), first (Q1), and third (Q3) quartiles were calculated, with the Mann–Whitney U test and its p-value (p_mu) used for group comparisons. For ordinal or numerical paired variables, Spearman's correlation coefficient and its p-value (r (p)) were computed. To identify associations between categorical variables, the Chi-square test for the corresponding contingency tables and its p-value ($p(\chi^2)$) were applied. When expected frequencies in some cells were less than 5, Yates' correction for continuity was used. To illustrate the relationship between binary indicators, correspondence analysis was employed.

Results It was found that among individuals with disabilities due to diabetes mellitus, the most prevalent activity limitations were in self-care and mobility at the first degree of severity, and in work activity and self-care at the second and third degrees.

Conclusion Expert and rehabilitation diagnostics of individuals with disabilities of different age groups and various diabetes-related complications, who underwent medical and social assessment, provide individualized information regarding the necessary scope of rehabilitation interventions in accordance with the International Classification of Functioning, Disability and Health (ICF). Conducting expert-rehabilitation and medical-social diagnostics in this population enables forecasting of diagnostic volumes, disease progression, and the utilization of medical and rehabilitation services.

KEYWORDS: *disability, diabetes mellitus, age groups, clinical and functional impairments, activity limitations*

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1. INTRODUCTION

Diabetes mellitus belongs to the category of diseases with a steadily increasing prevalence and poses a significant threat due to early disability and high mortality rates associated with vascular complications. According to the International Diabetes Federation (IDF), the number of people aged 20 to 79 diagnosed with diabetes has reached 573 million worldwide. The prevalence of diabetes continues to grow annually. Experts estimate that by 2030, the number of diabetes patients will increase by 1.5 times to 552 million, meaning that approximately one in ten individuals globally will be diagnosed with the disease. By 2045, the number is projected to nearly double, reaching 783 million people (a 46% increase) [1,3,4,5,6].

Morbidity and disability are among the most critical indicators of public health. The significant increase in disability prevalence among citizens is associated with rising disease incidence, an aging population with a larger proportion of individuals beyond working age, and expanded criteria for disability determination. This situation requires a comprehensive approach to its resolution [2,7,8].

Particular attention should be given to the issues of comprehensive medical and social rehabilitation for this group of individuals with disabilities, whose disease progression presents specific challenges and characteristics.

In accordance with Federal Law No. 651-FZ of December 25, 2023, "On Amendments to Certain Legislative Acts of the Russian Federation," most of which came into force on March 1, 2025, a national system for comprehensive rehabilitation and habilitation of persons with disabilities is being established [11]. According to this regulatory framework, comprehensive rehabilitation and habilitation include the following key areas: medical rehabilitation, sanatorium-resort treatment, prosthetic and orthopedic care, professional, social, sociocultural, and physical rehabilitation and habilitation, early intervention for children and their families, and the provision of technical rehabilitation equipment [9,10].

The implementation of rehabilitation measures based on "interagency cooperation" requires clarification of the demand for capacity (including medical resources) to address activity limitations in persons with disabilities. The determination of such needs must be grounded in the assessment of the severity of functional impairments. This necessity formed the basis for the present study.

2. RESEARCH OBJECTIVE

To assess the degree of activity limitations in individuals with disabilities due to diabetes mellitus, based on clinical and functional impairments, in order to evaluate the need for developing comprehensive rehabilitation programs for this population.

3. MATERIALS AND METHODS

The study was structured in Excel tables and employed the following methods: document analysis and data extraction (320 cases). The data prepared for analysis in .xlsx format were uploaded into the R environment. Data processing and analysis were conducted using scripts in R. For continuous normally distributed variables, the mean and standard deviation were calculated; comparisons between two groups were performed using the Student's t-test. For continuous non-normally distributed variables, the mean (M) and standard deviation (SD) were computed, and the p-value of the t-test (p_t) was used for group comparisons. For continuous non-normally distributed variables, the median (Me), first (Q1), and third (Q3) quartiles were calculated, and the Mann–Whitney U test and its p-value (p_mu) were applied for comparing groups.

For ordinal or numerical variables, Spearman's correlation coefficient and its p-value (r (p)) were calculated for each variable pair. To determine associations between categorical variables, the Chi-square test was applied to the corresponding contingency tables, along with its p-value ($p(\chi^2)$). When the expected frequency in certain cells was <5, Yates' correction for continuity was used. To demonstrate the relationship between binary indicators, correspondence analysis was employed. The initial dataset was processed and analyzed using R, a free software environment for statistical computing and graphics [https://www.r-project.org].

4. RESULTS

The study revealed the following medical and social characteristics among individuals with disabilities due to diabetes mellitus: men accounted for 54.7%, women for 45.3%. Among them, 4.0% were classified as young age, 28.0% as middle-aged, and 31.0% as above working age. The analysis was based on data for 320 individuals with diabetes-related disabilities, assessed either for the first time or during follow-up examinations at the branch offices of the Federal State Institution "Main Bureau of Medical and Social Expertise in Moscow" of the Ministry of Labour of Russia.

The dataset included socio-demographic characteristics, physical data, clinical indicators, laboratory and instrumental findings, and expert-rehabilitation parameters.

Higher education was noted in 19.9% of individuals, secondary specialized education in 43.6%, general secondary education in 19.5%, and basic general education in 15.8%.

In terms of age structure, the majority of persons with disabilities were above working age—163 individuals (51.0%), followed by young adults—93 individuals (29.0%), and middle-aged adults—64 individuals (20.0%).

Regarding the disability distribution, the largest proportion was composed of individuals with Group III disability—194 individuals (61.0%), while Group I had the smallest share—34 individuals (11.0%). Group II included 92 individuals (29.0%).

An analysis was conducted to identify the most frequently recorded clinical symptoms in order to assess the severity of persistent functional impairments in individuals with disabilities caused by diabetes mellitus. The most commonly reported clinical symptoms included general malaise (56.0%), limb pain (45.0%), paresthesia of the extremities (43.0%), cardiovascular disorders (37.0%), dizziness (34.0%), visual impairment (29.0%), movement disorders (27.0%), headache (26.0%), glycemic abnormalities (24.0%), dry mouth (22.0%), and weakness in the limbs (14.0%).

As shown in Table 1, headaches were reported by 57 individuals out of 186 (30.6%) in Disability Group III and by 23 out of 123 individuals (18.7%) in Group II ($\chi^2 = 0.027$, $r = -0.13$). Hyper/hypoglycemia was observed in 64 out of 186 individuals (34.4%) in Group III and in 11 out of 128 cases (8.9%) in Group II ($\chi^2 = 0$, $r = -0.29$). Thirst and dry mouth were reported by 54 out of 186 individuals (29.0%) in Group III and in 18 out of 123 cases (14.6%) in Group II ($\chi^2 = 0.005$, $r = -0.16$). Paresthesia was recorded in 146 out of 275 individuals (53.1%) in Groups II and III, and in 8 out of 34 individuals (23.5%) in Group I. Phantom limb pain was present in 4 out of 136 individuals (2.2%) in Group III and in 14 out of 123 individuals (11.4%) in Group II ($\chi^2 = 0.002$, $r = -0.20$).

Hyper- and hypoglycemia were recorded in 42 out of 97 individuals (43.3%) with type 1 diabetes and in 34 out of 212 individuals (16.0%) with type 2 diabetes ($p = 0$; corr = -0.29). Movement difficulties were reported by 10 out of 97 individuals (10.3%) with type 1 diabetes and by 73 out of 212 (34.4%) with type 2 diabetes ($p = 0$; corr = 0.25). Limb shortening, absence, or phantom limb pain was observed in 2 out of 97 individuals (2.1%) with type 1 diabetes and in 36 out of 212 (17.0%) with type 2 diabetes ($p = 0$; corr = 0.21). Hearing loss was noted in 3 out of 97 individuals (3.1%) with type 1 diabetes and in 36 out of 212 (17.0%) with type 2 diabetes ($p = 0.001$; corr = 0.19). Limb pain was present in 36 out of 97 individuals (37.1%) with type 1 diabetes and in 121 out of 212 (57.1%) with type 2 diabetes ($p = 0.002$; corr= 0.19). Seizures occurred in 28 out of 97 individuals (28.9%) with type 1 diabetes and in 29 out of 212 (13.7%) with type 2 diabetes ($p = 0.002$; corr = -0.18). General malaise was noted in 43 out of 97 individuals (44.3%) with type 1 diabetes and in 129 out of 212 (60.8%) with type 2 diabetes ($p = 0.01$; corr = 0.15). Cardiovascular disorders were observed in 26 out of 97 individuals (26.8%) with type 1 diabetes and in 88 out of 212 (41.5%) with type 2 diabetes ($p = 0.018$; corr = 0.14). Edema was recorded in 7 out of 97 individuals (7.2%) with type 1 diabetes and in 35 out of 212 (16.5%) with type 2 diabetes ($p = 0.042$; corr = 0.13). Acute respiratory infections and cough were noted in 5 out of 97 individuals (5.2%) with type 1 diabetes and in 2 out of 212 (0.9%) with type 2 diabetes ($p = 0.058$; corr = -0.13) (Table 2).

As shown in Table 3, mental function impairments were recorded in 1.6% of cases and were classified as moderate. Sensory function impairments were registered in 9.4% of cases as moderate and in 5.0% as severe. Visual (sensory) impairments were found to be moderate in 3.1% of cases.

Impairments in neuromuscular, skeletal, and postural-dynamic functions were observed in 35.3% as moderate, 19.4% as severe, and 2.5% as significantly severe.

Cardiovascular function impairments were recorded in 25.3% of cases as moderate and in 13.8% as severe.

Table 1. Comparative structure of clinical symptoms in individuals with disabilities due to diabetes mellitus, by disability group (absolute number, %)

Clinical symptoms	Total n = 309		Disability group						$p(\chi^2)$	R (p)
			III (n=186)		II (n=89)		I (n=34)			
	Abs.	%	Abs.	%%	Abs.	%	Abs.	%		
Headache	80	25,9	57	30,6	17	19,1	6	17,7		-0,13
Hyper-/hypoglycemia	75	24,3	64	34,4	9	10,1	2	5,9	<0,001	-0,29 (<0,001)
Thirst, dry mouth	72	23,3	54	29,0	13	14,6	5	14,7	0,014	-0,16 (0,004)
Paresthesia	154	49,8	103	55,4	43	48,3	8	23,5	0,003	-0,16 (0,004)
Motor disturbances	83	26,9	44	23,7	33	37,1	6	17,7	0,028	>0,05
Phantom pain	18	5,8	4	2,15	9	10,1	5	14,7	0,001	0,2 (<0,001)

Table 2. Distribution of complications and comorbid conditions among individuals with disabilities due to diabetes mellitus, by diabetes type (absolute number, %)

Clinical Signs	**Total (n=399)**		**Type of Diabetes Mellitus**				$p(\chi^2)$	r(p)
			Type 1 (n=97)		**Type 2 (n=212)**			
	Abs.	**%**	**Abs.**	**%**	**Abs.**	**%**		
Hyper-/hypoglycemia	76	24,6	42	43,3	34	16,0	<0,001	-0,29 (0)
Movement difficulties	83	26,9	10	10,3	73	34,4	<0,001	0,25 (0)
Limb shortening, absence, or phantom pain	38	12,3	2	2,06	36	17,0	<0,001	0,21 (0)
Hearing loss	39	12,6	3	3,09	36	17,0	0,001	0,19 (0,001)
Limb pain	157	50,8	36	37,1	121	57,1	0,002	0,19 (0,001)
Seizures	57	18,4	28	28,9	29	13,7	0,002	-0,18 (0,001)
General malaise	172	55,7	43	44,3	129	60,8	0,010	0,15 (0,007)
Cardiovascular disorders	114	36,9	26	26,8	88	41,5	0,018	0,14 (0,013)
Acute respiratory infections, cough	7	2,27	5	5,15	2	0,94	0,033	-0,13 (0,021)
Edema	42	13,6	7	7,22	35	16,5	0,042	0,13 (0,027)
Dizziness	104	33,7	25	25,8	79	37,3	0,064	0,11 (0,048)
Digestive system	13	4,21	7	7,22	6	2,83	0,122	

disorders								
Spinal pain	39	12,6	8	8,25	31	14,6	0,167	
Vision loss	91	29,4	24	24,7	67	31,6	0,274	
Genitourinary system dysfunction	35	11,3	8	8,25	27	12,7	0,336	
Headache	77	24,9	28	28,9	49	23,1	0,346	
Thirst, dry mouth	72	23,3	19	19,6	53	25,0	0,368	
Tics, tremor	6	1,94	3	3,09	3	1,42	0,382	
Emotional and mental disorders	30	9,71	12	12,4	18	8,49	0,389	
Cognitive impairments	41	13,3	10	10,3	31	14,6	0,392	
Weakness in limbs	44	14,2	11	11,3	33	15,6	0,417	
Limb discomfort	5	1,62	2	2,06	3	1,42	0,651	
Chills	33	10,7	12	12,4	21	9,91	0,651	
Trophic disorders	26	8,41	7	7,22	19	8,96	0,770	
Spinal deformity	9	2,91	3	3,09	6	2,83	1,000	
Slow wound healing	14	4,53	4	4,12	10	4,72	1,000	
Movement limitation	13	4,21	4	4,12	9	4,25	1,000	
Paresthesia	152	49,2	48	49,5	104	49,1	1,000	
Sweating	11	3,56	3	3,09	8	3,77	1,000	
Heaviness	5	1,62	1	1,03	4	1,89	1,000	

Impairments in genitourinary system function were observed in 11.6% of cases as moderate, in 7.8% as severe, and in 5.6% as very severe. Overall, moderate impairments were recorded in 60.9% of individuals, severe in 28.4%, and very severe in 10.6%.

As shown in Table 4, in most cases, there were no statistically significant associations between gender and the severity of functional impairments. The only exception was found in neuromuscular, skeletal, and postural-dynamic functions, where moderate and very severe impairments were present in 110 out of 183 individuals (60.1%) ($p = 0.032$).

Severe mental function impairments were noted in 1.94% of individuals with type 1 diabetes mellitus and in 0.93% of those with type 2 diabetes mellitus ($p = 0.056$, $r = -0.11$).

Moderate sensory impairments were recorded in 1.94% of individuals with type 1 diabetes and in 13.0% with type 2 diabetes; severe impairments were present in 3.88% and 5.56%, respectively ($p = -0.067$, $r = -0.10$). Moderate neuromuscular, skeletal, and movement-related impairments were observed in 9.71% of individuals with type 1 diabetes and in 47.7% with type 2 diabetes; severe impairments were reported in 6.8% and 25%, respectively ($p = 0.55$, $r = 0.001$). Cardiovascular system impairments were reported as moderate in 4.85% of individuals with type 1 diabetes and in 35.2% with type 2 diabetes; severe impairments were observed in 0.97% and 19.4%, respectively ($p < 0.001$, $r = 0.53$).

Moderate impairments in endocrine system function and metabolism were noted in 82.5% of individuals with type 1 diabetes and in 52.3% with type 2 diabetes; severe impairments were observed in 10.7% and 37.5%, and very severe impairments in 6.8% and 6.48%, respectively ($p < 0.001$, $r = 0.20$).

Impairments in genitourinary system function in individuals with type 1 diabetes were reported as follows: moderate – in 2.91%, severe – in 1.94%, and very severe – in 5.83% of cases. Among those with type 2 diabetes, moderate impairments were observed in 34 individuals (15.7%), severe in 10.6%, and very severe in 5.56% ($p = 0.03$, $r = -0.12$).

Moderate overall functional impairments were recorded in 81 individuals (78.6%) with type 1 diabetes and in 52.8% with type 2 diabetes; severe impairments were reported in 13.6% and 35.2%, and very severe in 7.77% and 12.0%, respectively ($p < 0.01$, $r = 0.23$) (Table 5).

Table 3. Characteristics of functional impairments in individuals with disabilities due to diabetes mellitus by severity (absolute number, %)

Functional Impairment	Severity level									
Mental function impairments	Normal		Mild		Moderate		Severe		Very severe	
Language and speech function impairments	Abs.	Proportion	Abs.	Proportion	Abs.	Proportion	Abs.	Proportion	Abs.	Proportion
Sensory function impairments	301	94,1	9	28,0	5	1,6	4	1,2	1	0,3
Auditory sensory function impairments	316	98,8	3	0,9	1	0,3	0	0	0	0
Visual sensory function impairments	122	38,1	148	46,2	30	9,4	16	5,0	4	1,2
Neuromuscular, skeletal, and postural-dynamic function impairments	312	97,5	6	1,9	2	0,6	0	0	0	0
Cardiovascular system function impairments	192	60	102	31,9	10	3,1	12	3,8	4	1,2
Respiratory system function impairments	81	25,3	56	17,5	113	35,3	62	19,4	8	2,5
Digestive system function impairments	105	32,8	87	27,2	81	25,3	44	13,8	3	0,9
Endocrine system and metabolic function impairments	304	95	14	4,4	2	0,6	0	0	0	0
Hematologic and immune system function impairments	292	91,2	25	7,8	1	0,3	2	0,6	0	0
Genitourinary system function impairments	3	0,9	6	1,9	198	61,9	92	28,7	21	6,6

Skin and related structure impairments	289	90,3	24	7,5	3	0,9	2	0,6	2	0,6
Impairments due to physical disfigurement	164	51,2	76	23,8	37	11,6	25	7,8	18	5,6
Total functional impairments	313	97,8	6	1,9	0	0	1	0,3	0	0
Functional Impairment	315	98,4	1	0,3	4	1,2	0	0	0	0
Mental function impairments	0	0	0	0	195	60,9	91	28,4	34	10,6

Table 4. Gender-specific characteristics of functional impairments in individuals with disabilities due to diabetes mellitus by severity (absolute number, %)

Functional Impairments in Individuals with Disabilities	Severity of Functional Impairments	Gender			
		Female		Male	
		Abs.	%	Abs.	%
Mental function impairments	Normal	138	95,2	163	93,1
	Mild	4	2,76	5	2,86
	Moderate	1	0,69	4	2,29
	Severe	2	1,38	2	1,14
	Very severe	0	0	1	0,57
Language and speech function impairments	Normal	145	100,0	171	97,7
	Mild	0	0	3	1,71
	Moderate	0	0	1	0,57
Sensory function impairments	Normal	58	40,0	64	36,6
	Mild	62	42,8	86	49,1
	Moderate	15	10,3	15	8,57
	Severe	9	5,52	8	4,57
	Very severe	2	1,38	2	1,14
Visual sensory function impairments	Normal	83	57,2	109	62,3
	Mild	46	31,7	56	32,0
	Moderate	8	5,52	2	1,14
	Severe	6	4,14	6	3,43
	Very severe	2	1,38	2	1,14
Neuromuscular, skeletal, and movement-related (postural-dynamic) function impairments	Normal	40	27,6	41	23,4
	Mild	32	22,1	24	13,7
	Moderate	43	29,7	70	40,0
	Severe	28	19,3	34	19,4
	Very severe	2	1,38	0	3,43

Cardiovascular system function impairments	Normal	50	34,5	55	31,4
	Mild	48	29,7	44	25,1
	Moderate	34	23,4	47	26,9
	Severe	17	11,7	27	15,4
	Very severe	1	0,69	2	1,14
Respiratory system function impairments	Normal	137	94,5	167	95,4
	Mild	8	5,52	6	3,43
	Moderate	0	0	2	1,14
Digestive system function impairments	Normal	132	91,0	160	91,4
	Mild	11	7,59	14	8,0
	Moderate	0	0	1	0,57
	Severe	2	1,38	0	0
Endocrine and metabolic function impairments	Normal	2	1,38	1	0,57
	Mild	1	0,69	5	2,86
	Moderate	93	64,1	105	60,0
	Severe	41	28,3	51	29,1
	Very severe	8	5,52	19	7,43
Hematologic and immune system impairments	Normal	128	88,3	161	92,0
	Mild	14	9,66	10	5,71
	Moderate	1	0,69	2	1,14
	Severe	1	0,69	1	0,57
	Very severe	1	0,69	1	0,57
Genitourinary system function impairments	Normal	69	47,6	95	54,3
	Mild	35	24,1	41	23,4
	Moderate	22	15,2	15	8,57
	Severe	12	8,28	13	7,43
	Very severe	7	4,83	11	6,29
Skin and related structure impairments	Normal	141	97,2	172	98,3
	Mild	3	2,07	3	1,7
	Severe	1	0,69	0	0
Impairments due to physical disfigurement	Normal	142	97,9	173	98,9
	Mild	1	0,69	0	0
	Moderate	2	1,38	2	1,14
Total functional impairments	Moderate	91	62,8	104	59,4
	Severe	41	28,3	50	28,6
	Very severe	13	8,97	21	12,0

As shown in Table 6, lipodystrophy was observed in 23 out of 103 individuals (22.3%) with type 1 diabetes mellitus and in 2 out of 216 cases (0.9%) with type 2 diabetes mellitus (p = 0, r = -0.37). Diabetic polyneuropathy was recorded in 95 out of 103 individuals (92.2%) with type 1 diabetes and in 160 out of 216 individuals with type 2 diabetes (p = 0, r = -0.21).

Macroangiopathy was identified in 17 out of 103 individuals (16.5%) with type 1 diabetes and in 123 out of 216 individuals (56.9%) with type 2 diabetes (p = 0, r = 0.38). Peripheral angiopathy was observed in 10 out of 103 individuals (9.7%) with type 1 diabetes and in 68 out of 216 individuals (31.5%) with type 2 diabetes (p = 0, r = 0.24).

Chronic arterial insufficiency of grade 2 was detected in 7 out of 103 individuals (6.8%) with type 1 diabetes and in 68 out of 216 individuals (31.5%) with type 2 diabetes (p = 0, r = 0.27). Atherosclerosis of the lower limb arteries was diagnosed in 6 out of 103 individuals (5.8%) with type 1 diabetes and in 67 out of 216 individuals (31%) with type 2 diabetes (p = 0, r = 0.28).

Table 5. Correlation coefficients between the severity of functional impairments and type of diabetes mellitus

Names of Functional Impairments	Severity Level	Total	Type 1 DM	Type 2 DM	r(p)
Mental functions	Normal	300 (94,0%)	93 (90,3%)	207 (95,8%)	-0,11(0,056)
	Mild	9 (2,82%)	6 (5,83%)	3 (1,39%)	
	Moderate	5 (1,57%)	2 (1,94%)	3 (1,39%)	
	Severe	4 (1,25%)	2 (1,94%)	2 (0,93%)	
	Very severe	1 (0,31%)	0 (0,00%)	1 (0,46%)	
Language and speech functions	Normal	315 (98,7%)	101 (98,1%)	214 (99,1%)	N/A
	Mild	3 (0,94%)	1 (0,97%)	2 (0,93%)	
	Moderate	1 (0,31%)	1 (0,97%)	0 (0,00%)	
Sensory functions	Normal	121 (37,9%)	24 (23,3%)	97 (44,9%)	-0,1(-0,067)
	Mild	148 (46,4%)	71 (68,9%)	77 (35,6%)	
	Moderate	30 (9,40%)	2 (1,94%)	28 (13,0%)	
	Severe	16 (5,02%)	4 (3,88%)	12 (5,56%)	
	Very severe	4 (1,25%)	2 (1,94%)	2 (0,93%)	
Sensory functions (auditory)	Normal	311 (97,5%)	100 (97,1%)	211 (97,7%)	N/A
	Mild	6 (1,88%)	2 (1,94%)	4 (1,85%)	
	Moderate	2 (0,63%)	1 (0,97%)	1 (0,46%)	
Sensory functions (visual)	Normal	191 (59,9%)	69 (67,0%)	122 (56,5%)	0,11(0,059
	Mild	102 (32,0%)	29 (28,2%)	73 (33,8%)	
	Moderate	10 (3,13%)	0 (0,00%)	10 (4,63%)	
	Severe	12 (3,76%)	3 (2,91%)	9 (4,17%)	
	Very severe	4 (1,25%)	2 (1,94%)	2 (0,93%)	
Neuromuscular, skeletal, and movement-related (postural-dynamic) functions	Normal	81 (25,4%)	61 (59,2%)	20 (9,26%)	0,55(<0,001)
	Mild	56 (17,6%)	25 (24,3%)	31 (14,4%)	
	Moderate	113 (35,4%)	10 (9,71%)	103 (47,7%)	
	Severe	61 (19,1%)	7 (6,80%)	54 (25,0%)	
	Very severe	8 (2,51%)	0 (0,00%)	8 (3,70%)	

Cardiovascular system	Normal	105 (32,9%)	67 (65,0%)	38 (17,6%)	0,53(<0.001)
	Mild	87 (27,3%)	30 (29,1%)	57 (26,4%)	
	Moderate	81 (25,4%)	5 (4,85%)	76 (35,2%)	
	Severe	43 (13,5%)	1 (0,97%)	42 (19,4%)	
	Very severe	3 (0,94%)	0 (0,00%)	3 (1,39%)	
Respiratory system	Normal	303 (95,0%)	98 (95,1%)	205 (94,9%)	N/A
	Mild	14 (4,39%)	4 (3,88%)	10 (4,63%)	
	Moderate	2 (0,63%)	1 (0,97%)	1 (0,46%)	
Digestive system	Normal	291 (91,2%)	92 (89,3%)	199 (92,1%)	N/A
	Mild	25 (7,84%)	11 (10,7%)	14 (6,48%)	
	Moderate	1 (0,31%)	0 (0,00%)	1 (0,46%)	
	Severe	2 (0,63%)	0 (0,00%)	2 (0,93%)	
Endocrine system and metabolism	Normal	2 (0,63%)	0 (0,00%)	2 (0,93%)	0,2(<0.001)
	Mild	6 (1,88%)	0 (0,00%)	6 (2,78%)	
	Moderate	198 (62,1%)	85 (82,5%)	113 (52,3%)	
	Severe	92 (28,8%)	11 (10,7%)	81 (37,5%)	
	Very severe	21 (6,58%)	7 (6,80%)	14 (6,48%)	
Hematologic and immune system	Normal	288 (90,3%)	95 (92,2%)	193 (89,4%)	N/A
	Mild	24 (7,52%)	7 (6,80%)	17 (7,87%)	
	Moderate	3 (0,94%)	0 (0,00%)	3 (1,39%)	
	Severe	2 (0,63%)	0 (0,00%)	2 (0,93%)	
	Very severe	2 (0,63%)	1 (0,97%)	1 (0,46%)	
Genitourinary system	Normal	163 (51,1%)	57 (55,3%)	106 (49,1%)	0,12(0,03)
	Mild	76 (23,8%)	35 (34,0%)	41 (19,0%)	
	Moderate	37 (11,6%)	3 (2,91%)	34 (15,7%)	
	Severe	25 (7,84%)	2 (1,94%)	23 (10,6%)	
	Very severe	18 (5,64%)	6 (5,83%)	12 (5,56%)	
Skin and related structures	Normal	312 (97,8%)	100 (97,1%)	212 (98,1%)	N/A
	Mild	6 (1,88%)	3 (2,91%)	3 (1,39%)	
	Severe	1 (0,31%)	0 (0,00%)	1 (0,46%)	
Impairments due to physical disfigurement	Normal	314 (98,4%)	103 (100%)	211 (97,7%)	N/A
	Mild	1 (0,31%)	0 (0,00%)	1 (0,46%)	
	Moderate	4 (1,25%)	0 (0,00%)	4 (1,85%)	
Total impairments	Moderate	195 (61,1%)	81 (78,6%)	114 (52,8%)	0,23(<0,001)
	Severe	90 (28,2%)	14 (13,6%)	76 (35,2%)	
	Very severe	34 (10,7%)	8 (7,77%)	26 (12,0%)	

Table 6. Statistically significant differences in complication frequencies between individuals with disabilities due to type 1 and type 2 diabetes mellitus (absolute number, %)

ICD-10 Code	Complication	Total		Types of Diabetes				p (x^2)	R (p)
E03	Hypothyroidism			I (n=103)		II (n=216)			
E78.0	Dyslipidemia	Abs.	%	Abs.	%	Abs.	%		
E88.1	Lipodystrophy	3	0,94	3	2,91	0	0,00	0.033	-0,14 (0,012)
G60	Autonomic neuropathy	7	2,19	5	4,85	2	0,93	0.038	-0,13 (0,025)
G63.2	Diabetic polyneuropathy	25	7,84	23	22,3	2	0,93	<0.001	-0,37 (<0,001)
I25	Ischemic heart disease, cardiosclerosis	14	4,39	13	12,6	1	0,46	<0.001	-0,28 (<0,001)
I50	Chronic heart failure (CHF)	255	79,9	95	92,2	160	74,1	<0.001	-0,21 (<0,001)
I70.2	Atherosclerosis of extremity arteries	16	5,02	1	0,97	15	6,94	0.044	0,13 (0,022)
I79.2	Peripheral angiopathy	75	23,5	7	6,80	68	31,5	<0.001	0,27 (<0,001)
K76.0	Hepatosis	73	22,9	6	5,83	67	31,0	<0.001	0,28 (<0,001)
Z89	Acquired limb absence	78	24,5	10	9,71	68	31,5	<0.001	0,24 (<0,001)
	Macroangiopathy	6	1,88	5	4,85	1	0,46	0.015	-0,15 (0,007)
	Diabetic foot syndrome	108	33,9	8	7,77	100	46,3	<0.001	0,38 (<0,001)
	Charcot foot	140	43,9	17	16,5	123	56,9	<0.001	0,38 (<0,001)
	Trophic disorders	110	34,5	11	10,7	99	45,8	<0.001	0,35 (<0,001)
N18	Chronic kidney disease (CKD), stage ≥3	17	5,33	1	0,97	16	7,41	0.033	0,13 (0,017)
ICD-10 Code	Complication	45	14,1	7	6,80	38	17,6	0.016	0,15(0,01)
E03	Hypothyroidism	80	25,1	13	12,6	67	31,0	<0.001	0,11(0,043)

Ischemic heart disease (IHD) and cardiosclerosis were observed in 1 out of 103 individuals (1.0%) with type 1 diabetes mellitus and in 15 out of 216 individuals (6.9%) with type 2 diabetes mellitus (p = 0.044; r = 0.13).

Charcot foot was diagnosed in 1 out of 103 individuals (1.0%) with type 1 diabetes and in 16 out of 216 individuals (7.4%) with type 2 diabetes (p = 0.033; r = 0.13).

Diabetic foot syndrome was reported in 11 out of 103 individuals (10.7%) with type 1 diabetes and in 99 out of 216 individuals (38.0%) with type 2 diabetes (p = 0; r = 0.35).

Trophic disorders were recorded in 7 out of 103 individuals (6.8%) with type 1 diabetes and in 38 out of 216 individuals (17.6%) with type 2 diabetes (p = 0.016; r = 0.15).

Hepatosis was observed in 5 out of 103 individuals (4.9%) with type 1 diabetes and in 1 out of 216 individuals (0.5%) with type 2 diabetes (p = 0.024; r = -0.15).

Acquired limb loss was recorded in 8 out of 103 individuals (7.8%) with type 1 diabetes and in 100 out of 216 individuals (46.3%) with type 2 diabetes (p = 0; r = 0.38).

Chronic kidney disease (CKD) stage ≥ 3 was diagnosed in 13 out of 103 individuals (12.6%) with type 1 diabetes and in 67 out of 216 individuals (31.0%) with type 2 diabetes (p = 0.001; r = 0.11).

Table 7. Statistically significant differences in complication frequencies among individuals with disabilities due to diabetes mellitus by disability group (absolute number, %)

ICD-10 Code	Complication	Disability Groups				p (x^2)
		III (n=194)		I-II (n=126)		
		Abs.	%	Abs.	%	
E21	Hyperparathyroidism	0	0	7	5,56	0,003
E88	Lipodystrophy	23	11,9	2	1,59	0,002
G63.2	Diabetic polyneuropathy	162	83,5	93	73,8	0,012
	Diabetic maculopathy	0	0	5	3,97	0,004

F98	Urinary incontinence	1	0,52	7	5,56	0,014
	Macroangiopathy	75	38,7	66	52,4	0,021
I70.2	Atherosclerosis of extremity arteries	37	19,1	37	29,4	0,046
D50	Iron deficiency anemia	2	1,03	12	9,52	<0,001
Z89	Acquired limb absence	46	23,7	62	49,2	<0,001

Hyperparathyroidism was recorded in 7 out of 126 individuals (5.6%) with Group I and II disability, while no cases were observed among individuals with Group III disability ($p = 0.003$; $r = 0.19$). Lipodystrophy was noted in 2 out of 126 individuals (1.6%) with Group I and II disability and in 23 out of 194 individuals (11.9%) with Group III disability ($p = 0.002$; $r = -0.19$). Diabetic polyneuropathy was registered in 93 out of 126 individuals (73.8%) in Groups I and II and in 162 out of 194 individuals (83.5%) in Group III ($p = 0.05$; $r = -0.12$). Diabetic maculopathy was identified in 5 out of 126 individuals (4.0%) with Group I and II disability and was not recorded in Group III ($p = 0.02$; $r = 0.16$). Urinary incontinence occurred in 7 out of 126 individuals (5.6%) in Groups I and II and in 1 out of 194 individuals (0.5%) in Group III ($p = 0.014$; $r = 0.16$).

Macroangiopathy was diagnosed in 66 out of 126 individuals (52.4%) in Groups I and II and in 75 out of 194 individuals (38.7%) in Group III ($p = 0.021$; $r = 0.14$). Atherosclerosis of the lower limb arteries was noted in 37 out of 126 individuals (29.4%) in Groups I and II and in 37 out of 194 individuals (19.1%) in Group III ($p = 0.046$; $r = 0.12$). Iron-deficiency anemia was found in 12 out of 126 individuals (9.5%) in Groups I and II and in 2 out of 194 individuals (1.0%) in Group III ($p = 0.001$; $r = 0.20$). Acquired limb loss was recorded in 62 out of 126 individuals (49.2%) in Groups I and II and in 46 out of 194 individuals (23.7%) in Group III ($p = 0$; $r = 0.26$) (Table 7).

As shown in Table 8, iron-deficiency anemia was recorded in 2 out of 194 individuals (1.03%) with Group III disability, in 5 out of 92 individuals (5.43%) with Group II disability, and in 7 out of 34 individuals (20.6%) with Group I disability ($r = 0.24$). Acquired limb loss was noted in 46 individuals with Group III disability (23.7%), in 48 individuals with Group II disability (52.2%), and in 14 individuals with Group I disability (41.2%) ($r = 0.24$).

Hyperparathyroidism was observed in 4.35% of individuals with Group II disability (4 out of 92) and in 8.82% with Group I disability (3 out of 34) ($r = 0.20$). Diabetic maculopathy occurred in 2 out of 92 individuals (2.17%) with Group II disability and in 3 out of 34 (8.82%) with Group I disability ($r = 0.19$). Lipodystrophy was registered in 23 out of 194 individuals (11.9%) with Group III disability, in 1 case with Group II disability (1.09%), and in 2.94% with Group I disability ($r = -0.18$).

Urinary incontinence was recorded in 0.52% of Group III, 4.35% of Group II, and 8.82% of Group I individuals ($r = 0.17$). Metabolic disorders were observed in 0.52% of Group III, 1.09% of Group II, and 8.82% of Group I individuals ($r= 0.14$). Diabetic polyneuropathy was present in 83.5% of Group III, 78.3% of Group II, and 61.8% of Group I individuals ($r = -0.14$). Dyslipidemia was recorded in 1.03% of Group III, 2.17% of Group II, and 8.82% of Group I individuals ($r = 0.12$). Macroangiopathy was registered in 75 out of 194 individuals (38.7%) in Group III, 50 out of 92 (54.3%) in Group II, and 16 out of 34 (47.1%) in Group I ($r = 0.12$).

A moderate positive correlation was observed between mental function impairments and impairments in language and speech functions ($r = 0.46$). A weak positive correlation was noted between mental function impairments and sensory function impairments ($r = 0.13$), as well as between sensory function impairments and mental function impairments ($r = 0.13$). A strong positive correlation was recorded between visual sensory function impairments and general sensory function impairments ($r = 0.67$). Visual sensory function impairments were also weakly correlated with genitourinary system impairments ($r = 0.18$) and with total functional impairments ($r = 0.12$).

A moderate positive correlation was found between neuromuscular, skeletal, and movement-related impairments and cardiovascular system dysfunction ($r = 0.57$), as well as with endocrine and metabolic system impairments ($r = 0.45$) and with total functional impairments ($r = 0.45$). Cardiovascular system dysfunction showed a moderate correlation with neuromuscular and postural-dynamic impairments ($r = 0.57$), endocrine and metabolic dysfunction ($r = 0.39$), a weak correlation with genitourinary system impairments ($r = 0.11$), and a moderate correlation with overall functional impairments ($r = 0.45$).

A weak positive correlation was found between respiratory system dysfunction and auditory sensory impairments (r = 0.15). Digestive system dysfunction showed a weak correlation with impairments in the hematopoietic and immune systems (r = 0.20). Endocrine and metabolic dysfunction was moderately correlated with neuromuscular and postural-dynamic impairments (r = 0.45), with cardiovascular dysfunction (r = 0.39), and showed a strong correlation with total functional impairments (r = 0.84).

Impairments in the hematopoietic and immune systems demonstrated a weak positive correlation with digestive system impairments (r = 0.20), genitourinary system impairments (r = 0.22), and overall functional impairments (r = 0.15). Total functional impairments showed a strong positive correlation with endocrine and metabolic system dysfunction (r = 0.84), a moderate correlation with neuromuscular and postural-dynamic impairments (r = 0.45), and cardiovascular system dysfunction (r = 0.45), as well as weak correlations with visual sensory function impairments (r = 0.12) and hematologic and immune system impairments (r = 0.15).

Neuromuscular, skeletal, and postural-dynamic dysfunction, cardiovascular system dysfunction, and endocrine and metabolic dysfunction each demonstrated a moderate positive correlation in both male and female individuals. A weak correlation was observed between genitourinary system impairments among women and sensory impairments among men. Overall functional impairments showed a moderate correlation for both men and women (Table 9).

Among individuals with diabetes-related disabilities, the highest proportion of activity limitations was observed in self-care: first-degree limitations – 66.9%, second-degree – 18.1%, and third-degree – 5.0%. Limitations in mobility were recorded as follows: first degree – 42.2%, second degree – 20.0%, and third degree – 2.5%. Orientation limitations were observed at 2.8% (first degree), 3.1% (second degree), and 1.2% (third degree). Learning limitations occurred in 4.4% (first degree), 0.6% (second degree), and 0.3% (third degree). Limitations in work activity were found in 56.9% of individuals at the first degree, 23.8% at the second degree, and 9.1% at the third degree (Table 10).

Table 8. Statistically significant correlation coefficients between the presence of diabetes-related complications and disability group (absolute number, %)

ICD-10 Code	Complication	Disability Groups						p (x^2)	R (p)
		III (n=194)		II (n=92)		I (n=34)			
		Abs.	%	Abs.	%	Abs.	%		
D50	Iron deficiency anemia	2	1,03	5	5,43	7	20,6	0,24	<0,001
Z89	Acquired limb absence	46	23,7	48	52,2	14	41,2	0,24	<0,001
E21.0	Hyperparathyroidism	0	0	4	4,35	3	8,82	0,2	<0,001
	Diabetic maculopathy	0	0	2	2,17	3	8,82	0,19	0,001
E88.1	Lipodystrophy	23	11,9	1	1,09	1	2,94	-0,18	0,001
F98	Urinary incontinence	1	0,52	4	4,35	3	8,82	0,17	0,002
E83	Metabolic disorder	1	0,52	1	1,09	3	8,82	0,14	0,012
G63.2	Diabetic polyneuropathy	162	83,5	72	78,3	21	61,8	-0,14	0,012
E78.0	Dyslipidemia	2	1,03	2	2,17	3	8,82	0,12	0,03
	Macroangiopathy	75	38,7	50	54,3	16	47,1	0,12	(0,028)

Table 9. Correlation between functional impairments and gender among individuals with disabilities

Type of impairment	All		Women		Men	
	r	p	r	p	r	p
Sensory (visual) function impairments	-	-	-	-	0,15	0,044
Neuromuscular, skeletal, and movement-related (postural-dynamic)	0,59	<0,001	0,58	<0,001	0,62	<0,001
Cardiovascular system function impairments	0,54	<0,001	0,5	<0,001	0,59	<0,001
Endocrine system and metabolic impairments	0,35	<0,001	0,4	<0,001	0,32	<0,001

Genitourinary system impairments	0,16	0,003	0,22	0,01	-	-
Total functional impairments	0,4	<0,001	0,4	<0,001	0,39	<0,001

Table 10. Characteristics of activity limitations in individuals with disabilities due to diabetes mellitus by severity (absolute number, %)

Types of Activity Limitations	Severity of Activity Limitations							
	Normal		First degree		Second degree		Third degree	
	Abs.	%	Abs.	%	Abs.	%	Abs.	%
Limitation in self-care ability	32	10,0	214	66,9	58	18,1	16	5,0
Limitation in mobility	113	35,3	135	42,2	64	20,0	8	2,5
Limitation in orientation	297	92,8	9	2,8	10	3,1	4	1,2
Limitation in learning ability	303	94,7	14	4,4	2	0,6	1	0,3
Limitation in work ability	33	10,3	182	56,9	76	23,8	29	9,1
Limitation in communication ability	311	97,2	5	1,6	4	1,2	1	0,3
Limitation in behavioral self-regulation	312	97,5	3	0,9	4	1,2	1	0,3

As shown in Table 11, a weak positive correlation was found between mental function impairments and limitations in self-care (r = 0.17) and orientation (r = 0.20), a moderate correlation with communication (r = 0.37), and a strong correlation with behavioral self-regulation (r = 0.66). Language and speech impairments were weakly correlated with self-care (r = 0.14), orientation (r = 0.20), and work activity (r = 0.16); a moderate correlation was observed with communication (r = 0.33), and a strong correlation with work activity (r = 0.70).

Hearing-related sensory impairments were weakly correlated with communication (r = 0.18), behavioral self-regulation (r= 0.12), and showed a moderate correlation with orientation (r = 0.41). In addition, hearing impairments demonstrated a weak correlation with work activity (r = 0.14) and communication (r = 0.19), and a moderate correlation with orientation (r = 0.41).

Neuromuscular, skeletal, and movement-related impairments showed a weak correlation with work activity (r = 0.23), a moderate correlation with self-care (r = 0.39), and a strong correlation with mobility (r = 0.70).

Cardiovascular system impairments demonstrated moderate correlations with work activity (r = 0.26), mobility (r = 0.49), and self-care (r = 0.34).

Endocrine and metabolic dysfunctions showed moderate correlations with self-care (r = 0.44), mobility (r = 0.42), and work activity (r = 0.49), and a weak correlation with orientation (r = 0.14).

Genitourinary system impairments showed a moderate correlation with work activity (r = 0.29) and weak correlations with self-care and behavioral self-regulation (r = 0.11).

Total functional impairments demonstrated weak correlations with orientation (r = 0.21), communication (r = 0.18), and behavioral self-regulation (r = 0.17); moderate correlations were observed with mobility (r = 0.48), self-care (r = 0.53), and work activity (r = 0.66).

Statistically significant Spearman correlations were found between subjective complaints and functional impairments. A strong correlation was observed between numbness and impairments of the skin and related structures (r = 0.14). Dizziness showed weak correlations with visual sensory impairments (r = 0.16) and genitourinary system dysfunction (r = 0.14).

Gait instability showed weak correlations with general sensory impairments (r = 0.14), auditory sensory impairments (r = 0.15), and visual sensory impairments (r = 0.21).

A weak positive correlation was identified between movement limitations and neuromuscular, postural-dynamic function impairments (r = 0.13). Phantom pain was moderately correlated with neuromuscular, skeletal, and movement-related impairments (r = 0.27), and weakly correlated with cardiovascular system dysfunction (r = 0.17), endocrine and metabolic dysfunction (r = 0.16), and total functional impairments (r = 0.20).

Edema showed a weak correlation with cardiovascular system dysfunction (r = 0.12) and genitourinary system dysfunction (r = 0.14). A weak positive correlation was found between hypotension and both visual sensory impairments (r = 0.17) and genitourinary dysfunction (r = 0.15). Vision decline was weakly correlated with sensory dysfunction in general (r = 0.19), and moderately correlated with visual sensory impairments specifically (r = 0.25).

Attention deficits demonstrated a weak correlation with hematologic and immune system impairments (r = 0.12). Tearfulness showed a weak correlation with digestive system dysfunction (r = 0.11), and irritability was weakly correlated with mental function impairments (r = 0.18). Memory impairment showed weak correlations with mental dysfunction (r = 0.20), language and speech impairments (r = 0.13), neuromuscular and postural-dynamic dysfunction (r = 0.13), and genitourinary dysfunction (r = 0.15).

A moderate positive correlation was found between disorientation and both mental dysfunction (r = 0.33) and language/speech impairments (r = 0.35). Complaints of heartburn showed a weak correlation with digestive system impairments (r = 0.21), and drowsiness showed a weak correlation with mental function impairments (r = 0.23).

Cough complaints were weakly correlated with respiratory system dysfunction (r = 0.16), and complaints of excessive sweating were weakly correlated with dysfunction of the skin and related structures (r = 0.21).

Complaints of urinary dysfunction showed weak correlations with mental dysfunction (r = 0.14), neuromuscular and movement-related dysfunction (r = 0.11), and genitourinary dysfunction (r = 0.13).

Complaints of hypotension demonstrated weak correlations with mental dysfunction (r = 0.14) and respiratory system dysfunction (r = 0.16). Cardiovascular system dysfunction was also weakly correlated with complaints of arrhythmia and unstable blood pressure (r = 0.11)

Table 11. Statistically significant correlation coefficients between functional impairments and activity limitations in individuals with disabilities due to diabetes mellitus.

Functional Impairments	Activity Limitations (Abilities)					
	Self-care	Mobility	Orientation	Communication	Work activity	Behavior control
Mental functions	0,17	-	0,2	0,37	-	0,66
Language and speech functions	0,14	-	0,2	0,32	0,16	0,7
Sensory functions	-	-	0,41	0,18	-	0,12
Sensory functions (auditory)	-	-	-	-	-	-
Sensory functions (visual)	-	-	0,41	0,19	0,14	-
Neuromuscular, skeletal, and movement-related functions (postural-dynamic)	0,39	0,7	-	-	0,23	-
Cardiovascular system functions	0,34	0,49	-	-	0,26	-
Endocrine system and metabolic functions	0,44	0,42	0,14	-	0,49	-
Hematologic and immune system functions	-	-	-	-	0,15	-
Genitourinary system functions	0,11	-	-	-	0,29	0,11
Functions impaired due to physical disfigurement	0,11	0,13	-	-	-	-
Total functional impairments	0,53	0,48	0,21	0,18	0,66	0,17

A weak positive correlation was identified between general fatigue complaints and dysfunction of the endocrine system (r= 0.15), hematologic system (r = 0.20), and overall functional impairments (r = 0.12). A weak correlation was also found between limb weakness and impairments in language and speech functions (r = 0.12), visual sensory functions (r = 0.13), neuromuscular and postural-dynamic functions (r = 0.13), cardiovascular system function (r = 0.12), and overall functional impairments (r = 0.12).

Tics were weakly correlated with mental dysfunction (r = 0.23), while dry mouth showed a weak correlation with mental function impairments (r = 0.11). Hearing loss was weakly correlated with impairments in language and speech (r = 0.13), and moderately correlated with auditory sensory dysfunction (r = 0.28). Appetite loss demonstrated a moderate positive correlation with gastrointestinal system impairments (r = 0.31).

5. CONCLUSION

Thus, the conducted study among individuals with disabilities due to diabetes mellitus provided a clearer understanding of the activity limitations that determine the need for rehabilitation measures, provision of assistive devices, and implementation of other types of rehabilitative support.

The presented algorithm for identifying functional impairments and activity limitations can be applied to patients undergoing medical and social assessment for this pathology at medical-social expertise institutions across the Russian Federation.

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Conflict of Interest Statement
The authors declare no conflicts of interest.

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