Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy Dovepress
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ORIGINAL RESEARCH

Type 2 Diabetes Correlates with Comorbidity and Nutritional Status but Not with Functional Health in Geriatric Ward Patients: A Cross-Sectional Study in Poland

This article was published in the following Dove Press journal:
Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy

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Purpose: The study aimed to assess the comorbidity profile, functional, and nutritional health in geriatric ward patients depending on their type 2 diabetes (DM) status.

Patients and Methods: We performed a cross-sectional study of 416 patients – median age 82 years (IQR 77–86), 77.4% female, 96.9% community-dwelling – consecutively admitted to the geriatric ward at the turn of 2014 and 2015. Comprehensive geriatric assessment results were analyzed (including self-care and instrumental activities of daily living, cognitive abilities, emotional health, risk of falls, frailty status, dynapenia, nutritional health, morbidity, biochemical parameters, and pharmacotherapy).

Results: DM was observed in 126 (30.3%) patients hospitalized in the study period; 4% of DM cases were newly diagnosed. In comparison to patients without DM, older adults with type 2 DM were significantly more frequently burdened with multimorbidity (61.1% versus 39.7%, P<0.001), polypharmacy (88.9% versus 74.7%, P=0.001), obesity (59.8% versus 34.5%, P<0.001), abdominal obesity (94.4% versus 75.5%, P<001), chronic kidney disease (61.1% versus 48.6%, P=0.02) and cardiovascular diseases: ischemic heart disease (66.7% versus 47.9%, P<0.001), congestive heart failure (50.0% versus 34.1%, P=0.002), atrial fibrillation (30.2% versus 20.7%, P=0.04) and peripheral arterial disease (24.6% versus 11.4%, p<0.001). There were no significant differences in all functional parameters evaluated.

Conclusion: Type 2 DM patients were significantly more often burdened with multimorbidity, polypharmacy, obesity, and had an unfavorable profile of cardiovascular diseases than patients without DM, but – contrary to our expectations – they did not differ in any functional characteristic assessed. However, this may be due to the geriatric ward patients' specificity of health problems in the advanced, more complex disablement process phases.

Keywords: diabetes, older adults, geriatric department, comprehensive geriatric assessment, obesity, disability, chronic diseases, multimorbidity

Summary

- Due to the aging of the population and the growing obesity epidemic, diabetes mellitus (DM) prevalence will increase in developed countries. It is associated with significant morbidity and mortality, but findings on its consequences for the geriatric population's functional status are inconsistent.
- We aimed to assess the health and functional correlations of type 2 DM in older patients admitted to the geriatric ward.

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DovePress
http://doi.org/10.2147/DMSO.S279388

- Type 2 DM patients were significantly more often burdened with multimorbidity, polypharmacy, obesity. They also had an unfavorable profile of cardiovascular diseases than patients without DM. Contrary to our expectations, they did not differ in any functional status characteristics that we assessed.
- The specificity of the health problems of patients hospitalized in the geriatric ward, being in the advanced or final phase of the disablement process, could influence the results, but it needs further research.

Introduction

Diabetes mellitus (DM) is one of the most common health problems in old age, associated with significant morbidity and mortality.[1] The disease burden of DM in developed countries is still growing. In 2019 its global prevalence was estimated to be 9.3% (463 million people) and projected to reach 10.9% (700 million) by 2045.[2] This is partly due to the aging population and the growing population obesity epidemic.[3] Body mass index (BMI) was the most vital factor associated with an increase in the prevalence of diabetes.[4]

Both obesity and diabetes and- at least partly- sarcopenia are known risk factors for developing physical disability among older adults.[5] Moreover, cardiovascular disease and other long-term DM complications can place these individuals at higher risk for functional impairment and worsen their prognosis.[6–8] However, some studies' results did not clearly show a relationship between diabetes and impaired performance in the elderly population.[9] Also, although ¼- 1/3 of geriatric wards patients have type 2 diabetes,[10,11] comparatively little is known to what extent DM correlates with a disability and chronic diseases profile in this specific population, generally seriously affected by multimorbidity and disability.[12] Therefore, the study aimed to explore health and functional correlates of type 2 DM in older patients admitted to the geriatric ward ("DM+" group), in comparison to those not burdened with the disease ("DM-" group).

Materials and Methods

We performed a secondary analysis of data collected during the cross-sectional study on frailty and multimorbidity in patients of the Department of Geriatrics (Hospital of the Ministry of Interior and Administration in Bialystok, Poland).[12,13] All consecutive patients, admitted mainly electively to the department at the turn of 2014 and 2015, took part in the study. One of the main goals of patients' stay in the ward being a sub-acute care facility is to conduct a comprehensive geriatric assessment and to create a long-term care plan. It is often impossible to indicate a single reason for hospitalization, as the overwhelming majority of patients have a multimorbidity and disability problem. The mean length of stay is seven days.

Patient Characteristics

We collected data on sociodemographic characteristics, the prevalence of 14 chronic diseases (peripheral arterial disease, ischemic heart disease, chronic cardiac failure, myocardial infarction, hypertension, atrial fibrillation, history of transient ischemic attack (TIA) or stroke, chronic obstructive pulmonary disease, neoplasm, dementia, parkinsonism, chronic osteoarthritis, osteoporosis, and chronic renal disease), medicines taken before hospitalization, history of hospitalizations and falls in the last 12 months. We verified information obtained from the patient by reviewing all of the patient's medical records, clinical examination results, and an interview with their guardians.

Measurements

We assessed patients' functional abilities with the results of tests carried out as a part of the comprehensive geriatric assessment, routinely performed for each patient hospitalized in the ward. The ability to perform self-care activities of daily living was assessed with the Barthel Index,[14] and instrumental activities of daily living (IADL) with six Duke Older American Resources and Services (OARS) items I-ADL.[15] Cognitive abilities were assessed with the Abbreviated Mental Test Score (AMTS).[16] The possibility of depression was evaluated with the 15- item Geriatric Depression Scale (GDS).[17] Dementia and depression diagnosis was based on a more in-depth neuropsychological examination. Walking speed was measured during the 4.6m walk from standing position in usual gait speed (the fastest time of 2 trials was used). According to the Southampton protocol, handgrip strength was measured in the dominant hand using a hand-held hydraulic dynamometer DHD-1 (SAEHAN, Changwon, South Korea).[18] Frailty was assessed with the 7-item Canadian study of health and aging Clinical Frailty Scale (CFS).[19] The risk of malnutrition was evaluated with the Mini Nutritional Assessment-Short Form (MNA-SF).[20] Body mass index (BMI), waist, and hips circumferences were measured according to the standard procedures. The waist-hip ratio was counted as the circumference of the waist divided by

that of the hips. The risk of recurrent falls was assessed with the Performance Oriented Mobility Assessment (POMA),[21] and with the Timed Up and Go Test (TUG).[22] For the self-reported physical activity level, the 4-level Saltin-Grimby physical activity level scale (SGPALS) was used.[23] Data on serum creatinine, albumin, fasting glucose, and the oral glucose tolerance test results were extracted from patients' medical records. Renal function was assessed with a glomerular filtration rate- GFR, counted using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) formula.[24] HbA_{1C} measurements were made with the immunoinhibition method using an Olympus AU400 analyzer (Beckman-Coulter, Brea, CA, USA).

Study Parameters

The DM+ group included patients diagnosed before the hospitalization and persons without a previous diagnosis fulfilling any of the following WHO criteria: fasting plasma glucose (FPG) ≥ 7.0 mMol/L (126 mg/dl) or 75 g oral glucose tolerance test (OGTT) with FPG ≥ 7.0 mMol/L (126 mg/dl) or 2-hour plasma glucose ≥ 11.1 mmol/L (200 mg/dl) or random plasma glucose ≥ 11.1 mmol/L (200 mg/dl) in the presence of typical diabetes symptoms.[25] Multimorbidity was defined as having 5 or more diseases of 14 listed above and taking 5 or more drugs was treated as polypharmacy. A score of 6 or 7 of CFS was classified as severe frailty.[26] Chronic kidney disease- ie stage 3, 4, and 5 CKD according to Kidney Disease Outcome Quality Initiative (KDOQI)- was diagnosed if GFR was <60mL/min/1.73m^2. Patients with BMI≥ 30kg/m^2 were classified as obese, according to the standard BMI ranges.[27] Those with BMI< 24kg/m^2 were treated as at risk for malnutrition, as recommended in the geriatric literature.[28] Malnutrition was also suspected if serum albumin was below 35g/L and if the MNA-SF score was below 8. Abdominal obesity was defined as waist circumference >80 cm in women and >94 cm in men. It was classified as severe- if the waist circumference value was above 88 cm in women and above 102 cm in men, and as mild- if the waist circumference was below these cut-offs.[29] Dynapenia (suggestive for probable sarcopenia) was derived from the handgrip strength, and it was diagnosed in men if grip strength was lower than 27 kgand in women if it was lower than 16 kg.[30] Gait speed equal or lower than 0.8 m/s, and/or TUG equal or higher than 20 s was treated as an impaired performance. If the patient with dynapenia had a poor result in one of these tests, dynapenia was treated as severe. Patients were classified with SGPALS as physically inactive if they were mainly reading, watching television, using computers or doing other sedentary activities during leisure-time.

Statistical Analysis

The IBM SPSS Version 18 Software suit (SPSS, Chicago, IL, USA) and STATISTICA 13.3 software package (TIBCO Software, Palo Alto, CA, USA) was used to analyze the data collected. The Shapiro–Wilk test was used to assess the distribution of variables. Data were presented as means (M) and standard deviation (SD) for normally distributed continuous variables, as medians (Me) and interquartile range (IQR) for not normally distributed ones and the number of cases and percentages for categorical variables. Proportions were compared using χ^2 tests or Fisher's exact test, as appropriate, while the independent samples Student's *t*-test and the Mann–Whitney *U*-test were used to compare the distribution of continuous variables. Missing values were omitted, and statistics in such cases were calculated for the adequately reduced groups. A P value of less than 0.05 was regarded as significant.

Ethics Approval and Informed Consent

It was a secondary analysis of data collected in the previous study. The Ethics Committee approved the source study at the Medical University of Bialystok (no R-I-002/305/2013). All procedures performed were following the ethical standards of the Medical University of Bialystok Ethics Committee and with the Helsinki declaration, and its later amendments. It is a study of usual practice. All study participants, or their guardians, gave their informed consent to participate in it.

Results

A total of 416 patients hospitalized during the study period took part in the analysis. Figure 1 presents the patients' enrollment into the study. The median age of patients was 82 years (IQR 77–86), and the majority of them were above 75 years of age (84.1%), female (77.4%), and community-dwelling (96.9%). There were 126 (30.3%) patients with diabetes (DM+ cases). In 5 (4%) patients, it was a newly diagnosed diabetes. Out of 121 patients diagnosed before hospitalization, 16 (13.2%) were only on a diabetic diet, and 105 (86.8%) received antidiabetic medications. A total of 48 (45.7%) patients on glucose-lowering agents received sulfonylureas, 65 (61.9%)- metformin, and 31 (29.5%) were on insulin. The HbA_{1C} was available in 98 DM cases, and its median value was 6.5

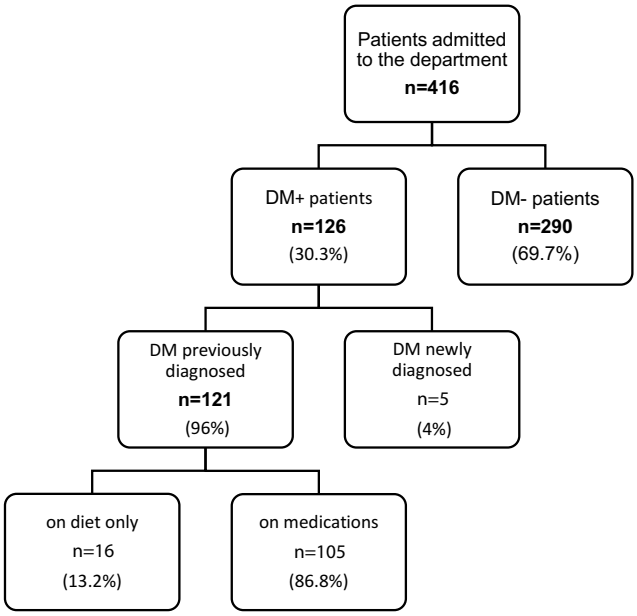

Figure 1 Flow chart of patients' enrollment.

(6.0, 7.8) %. In 61.2% of DM cases, the disease was tightly controlled, with HbA_{1C} ≤7% [53 mmol/mol], and only in 19.4% of DM cases, HbA_{1C} was above 8%.

DM+ patients and patients without DM did not differ in age, sex, place of residence, percentages of people living in long term care, and living alone. The groups differed significantly in the median number of chronic diseases (5.0, IQR 4.0–6.0 versus 4.0, IQR 3.0–5.0 in DM- group, P<0.001), and in the median number of medications taken (9.0, IQR 6.0–12.0 versus 6.0, IQR 4.0–9.0 in DM- group, P<0.001). DM+ patients were burdened significantly more often with multimorbidity (61.1% versus 39.7% in DM- group, P<0.001) and polypharmacy (88.9% versus 74.7% in DM- group, P<0.001).

The percentage of some diseases was significantly higher in the DM+ group: ischemic heart disease (66.7% versus 47.9% in DM- group, P<0.001), chronic cardiac failure (50.0% versus 34.1% in DM- group, P=0.002), peripheral arterial disease (24.6% versus 11.4% in DM- group, P<0.001), atrial fibrillation (30.2% versus 20.7% in DM- group, P=0.04), and chronic kidney disease (61.1% versus 48.6% in DM- group, P=0.02). The percentage of hypertension, history of myocardial infarction, TIA/stroke, osteoporosis, depression, and dementia, was not significantly different in both groups. Similar percentages of DM + and DM- patients reported hospitalization in the last year (information on the average number of hospitalizations was not available)- Table 1.

DM+ and DM- groups did not differ in any of the functional status parameters assessed in our study (Table 2) - they had similar scores of Barthel Index, IADL, AMTS, GDS, POMA, CFS, and Norton scale. There were no differences observed in handgrip strength, the prevalence of dynapenia, in gait speed, TUG results, the prevalence of severe frailty, or the percentage of patients classified as physically inactive with SGPALS.

Mean value of BMI was significantly higher in DM+ group (32,3± 6.1 kg/m2 versus 28.0±5.5 kg/m^2 in DM- group, P<0.001) and so were mean value of waist circumference (1.05 ± 0.14m versus 0.94± 0.12 m in DM- group, P<0.001) and median value of WHR (0.93, 0.88–0.96 versus 0.90, 0.86–0.95, P=0.002). The majority of patients with DM were obese according to BMI (59.8% versus 34.5% in non-DM, P<0.001) and had abdominal obesity (94.4%, compared to 75.5% of the non-DM group, P<0.001). In the latter case, a significant difference resulted mainly from the significantly more frequent occurrence of severe abdominal obesity in people with diabetes (82.2% versus 56.4% in the non-DM group, P<0.001). We did not observe any difference in the MNA-SF score and the prevalence of protein-energy malnutrition risk evaluated with this scale. There were no significant differences in serum albumin value and the percentage of patients with albumin <35g/L.

Due to the relatively large number of missing data, in the case of some functional state and nutritional status characteristics, an attempt was made to perform a comparative analysis of their number between people with and without DM. For all analyzed variables, the differences in the number of missing data between these groups were statistically insignificant (Table 3).

Discussion

The study confirmed that diabetes mellitus is a common health problem in older patients hospitalized in the geriatric ward. Its prevalence in our study was 30.3%. A total of 4% of all DM cases were diagnosed for the first time during this hospitalization, which confirms that diabetes can be asymptomatic for a long time and not diagnosed until old age. In our previous study, newly diagnosed DM was observed even more often- in 9% of cases.[10]

Patients admitted to a geriatric ward constitute a population seriously affected by multimorbidity and disability.[12] Nevertheless, the DM+ group's health was worse compared to non-DM participants in our study. The DM+ patients had a greater burden of chronic diseases and multimorbidity and significantly more often

Table 1 Characteristics of Study Participants- Sociodemographic and Health Correlates of DM

Characteristic	Total	DM+ Group	DM- Group	*P* value[a]	Missing Data
n (%)	416 (100.0)	126 (30.3)	290 (69.7)		
Sociodemographic characteristics					
Age, y, Me (IQR)	82 (77–86)	81 (76–85)	82.5 (78–86)	0.08	-
Age (75+), n (%)	350 (84.1)	103 (81.8)	247 (85.2)	0.38	-
Sex (M), n (%)	94 (22.6)	33 (26.2)	61 (21.03)	0.25	-
Residence (rural), n (%)	87 (20.9)	21 (16.7)	66 (22.8)	0.16	-
Living in long term care, n (%)	13 (3.1)	2 (1.6)	11 (3.8)	0.36	-
Living alone, n (%)	119 (29.8)	33 (27.5)	86 (30.8)	0.51	17
Health parameters					
Hospitalization in the last year, n (%)	122 (29.5)	36 (29.0)	86 (29.8)	0.88	3
Chronic diseases, Me (IQR)	4.0 (3.0–6.0)	5.0 (4.0–6.0)	4.0 (3.0–5.0)	<0.001	-
Multimorbidity, n (%)	192 (46.2)	77 (61.1)	115 (39.7)	<0.001	-
Dementia, n (%)	133 (32.0)	44 (34.9)	89 (30.7)	0.40	-
Depression, n (%)	181 (56.9)	52 (57.1)	129 (56.8)	1.0	-
Hypertension, n (%)	327 (78.6)	103 (81.8)	224 (77.2)	0.30	-
Ischemic heart disease, n (%)	223 (53.6)	84 (66.7)	139 (47.9)	<0.001	-
MI, CABG, PTCA, n (%)	39 (9.4)	17 (13.5)	22 (7.6)	0.07	
Chronic cardiac failure, n (%)	162 (38.9)	63 (50.0)	99 (34.1)	0.002	-
NYHA class I/II, n (%)	82 (19.7)	32 (25.4)	50 (17.2)		-
NYHA class III/IV, n (%)	80 (19.2)	31 (24.6)	49 (16.9)		-
Atrial fibrillation, n (%)	98 (23.6)	38 (30.2)	60 (20.7)	0.04	-
Peripheral arterial disease, n (%)	64 (15.4)	31 (24.6)	33 (11.4)	<0.001	-
Stroke/TIA, n (%)	56 (13.5)	21 (16.7)	35 (12.1)	0.20	-
Chronic osteoarthritis, n (%)	324 (77.9)	100 (79.4)	224 (77.2)	0.63	-
Osteoporosis, n (%)	74 (17.8)	21 (16.7)	53 (18.3)	0.70	-
Chronic kidney disease, n (%)	218 (52.4)	77 (61.1)	141 (48.6)	0.02	11
Number of drugs, Me (IQR)	7.0 (5.0–9.0)	9.0 (6.0–12.0)	6.0 (4.0–9.0)	<0.001	9
Polypharmacy, n (%)	322 (79.1)	112 (88.9)	210 (74.7)	0.001	9

Notes: [a]χ^2 test or Fisher exact test, as appropriate, for categorical variables; *t*-test for independent samples or Mann–Whitney test for continuous or interval variables. In all analyses a two-tailed P value of less than 0.05 was regarded as significant.

Abbreviations: CABG, coronary artery bypass graft; DM, diabetes mellitus; DM+, patients with diabetes; DM-, non-diabetic patients; IQR, interquartile range; M, mean value; Me, median value; MI, myocardial infarction; n, number of cases; NYHA, New York Heart Association; SD, standard deviation; PTCA, percutaneous transluminal coronary angioplasty; TIA, transient ischemic attack.

experienced polypharmacy. In this respect, our study confirmed other authors' findings that older adults with DM rarely have only one chronic disease.[31] Multimorbidity should be addressed not only in the literature (that is still mainly single disease-focused) but first of all in DM+ patients' care.[32] A consequence of this is also polypharmacy with a high risk of drug interactions. As a result, there is an increasing risk of hypoglycemia when antidiabetic medicines are taken simultaneously. The median HbA_{1C} in the group of DM patients was 6.5% in our study, so in half of them, the risk of recurrent hypoglycemia was undoubtedly high.

Our study confirmed that DM in patients admitted to the geriatric ward is connected primarily with the unfavorable profile of cardiovascular risk factors and predisposes to several cardiovascular diseases' co-occurrence.[33,34] DM+ and DM- patients did not differ in the prevalence of arterial hypertension only, the frequency of which exceeded 80% in the whole study group. In DM+ patients, significantly more often, obesity, abdominal obesity, ischemic heart disease, congestive heart failure, atrial fibrillation, and peripheral arterial disease were observed. We also observed a significant association between DM and renal impairment.

Contrary to our expectations and other authors' findings,[7] we did not notice any significant differences between DM+ and DM- groups in the functional parameters evaluated in our study. Our results are relatively

Table 2 Characteristics of Study Participants- Nutritional and Functional Correlates of DM

Parameter	Total	DM+ Group	DM- Group	*P* value[a]	Missing Data
No. (%) of Patients	**416 (100.0)**	**126 (30.3)**	**290 (69.7)**		
Functional characteristics					
Barthel Index, Me (IQR)	90.0 (70.0–100.0)	90.0 (70.0–100.0)	90.0 (70.0–100.0)	0.94	6
IADL, Me (IQR)	7.0 (3.0–11.0)	7.0 (2.0–10.0)	7.5 (3.0–11.0)	0.26	10
AMTS, Me (IQR)	8.0 (6.0–9.0)	8.0 (6.0–9.0)	8.0 (6.0–9.0)	0.59	35
GDS, Me (IQR)	7.0 (3.0–10.0)	6.0 (3.0–10.0)	7.0 (4.0–9.0)	0.67	52
Handgrip strength, kg, M (SD)	18.9 (7.4)	18.9 (7.3)	18.9 (7.4)	0.99	66
In men (N=76)	26.3 (8.3)	26.7 (7.6)	26.2 (8.6)	0.79	18
In women (N=274)	16.8 (5.6)	16.6(5.4)	16.9 (5.7)	0.66	48
Dynapenia, n (%)	164 (46.9)	49 (48.5)	115 (46.2)	0.72	66
Gait speed, m/s, Me (IQR)	0.65 (0.40–0.96)	0.66 (0.38–0.97)	0.64 (0.40–0.94)	0.93	102
Gait speed≤ 0.8m/s, n (%)	205 (65.3)	61(69.3)	144 (63.7)	0.43	102
POMA, Me (IQR)	23.0 (17.0–28.0)	22.0 (17.0–28.0)	24.0 (18.0–28.0)	0.47	94
POMA< 19, n (%)	95 (29.5)	31 (34.1)	64 (27.7)	0.26	94
TUG, s, Me (IQR)	17.4 (11.87–28.0)	19.23 (13.14–29.12)	16.9 (11.7–27.1)	0.32	115
TUG≥ 20s, n (%)	128 (42.5)	40 (44.9)	88 (41.5)	0.61	115
Falls in the last 12 months, n (%)	157 (43.9)	50 (48.1)	107 (42.1)	0.35	58
CFS, Me (IQR)	5.0 (4.0–5.0)	5.0 (4.0–6.0)	5.0 (4.0–5.0)	0.56	-
Severe frailty, n (%)	102 (24.5)	33 (26.2)	69 (23.8)	0.60	-
Norton scale score, Me (IQR)	17 (15–19)	17 (15–19)	17 (15–19)	0.89	6
SGPALS, sedentary, n (%)	168 (41.0)	55 (45.1)	113 (39.2)	0.28	6
Nutritional characteristics					
BMI, kg/m2, M (SD)	29.3 (6.0)	32.3 (6.1)	28.0 (5.5)	<0.001	62
BMI<24 kg/m2, n (%)	66 (18.6)	8 (8.8)	58 (23.0)	<0.001	62
BMI>30 kg/m2, n (%)	148 (41.8)	61 (59.8)	87 (34.5)	<0.001	62
WHR, Me (IQR)	0.90 (0.87–0.95)	0.93 (0.88–0.96)	0.90 (0.86–0.95)	0.002	63
Waist circumference, m, M (SD)	0.97 (0.13)	1.05 (0.14)	0.94 (0.12)	<0.001	52
In women (n=282)	0.96(0.13)	1.04 (0.14)	0.93 (0.12)	<0.001	40
In men (n=82)	1.02 (0.13)	1.09 (0.13)	0.98 (0.12)	<0.001	12
Abdominal obesity, n (%)	295 (81.0)	101 (94.4)	194 (75.5)	<0.001	52
Mild abdominal obesity, n (%)	62 (17.0)	13 (12.1)	49 (19.1)	0.13	52
Severe abdominal obesity, n (%)	233 (64.0)	88 (82.2)	145 (56.4)	<0.001	52
MNA-SF, Me (IQR)	12.0 (9.0–13.0)	12.0 (9.0–13.0)	11.0 (9.0–13.0)	0.53	12
MNA-SF<8, n (%)	72 (17.8)	24 (19.7)	48 (17.0)	0.52	12
Albumin, g/L, M (SD)	38.9 (3.8)	38.9 (3.7)	38.9 (3.8)	0.95	27
Albumin <35g/L, n (%)	58 (14.9)	17 (14.0)	41 (15.3)	0.88	27

Notes: [a]χ^2 test or Fisher exact test, as appropriate, for categorical variables; *t*-test for independent samples or Mann–Whitney test for continuous or interval variables. In all analyses a two-tailed P value of less than 0.05 was regarded as significant.

Abbreviations: AMTS, Abbreviated Mental Test Score; BMI, body mass index; CFS, 7 point Clinical Frailty Scale; DM, diabetes mellitus; DM+, patients with diabetes; DM-, non-diabetic patients; GDS, Geriatric Depression Scale; IADL, instrumental activities of daily living; IQR, interquartile range; M, mean value; Me, median value; MNA-SF, Mini Nutritional Assessment- Short Form; n, number of cases; POMA, Performance Oriented Mobility Assessment; SD, standard deviation; SGPALS, Saltin-Grimby physical activity level scale; TUG, Timed Up and Go Test; WHR, waist hip ratio.

parallel to the study results conducted by da Cruz Anjos et al., which did not confirm any negative impact of type 2 DM on the older women's functional status, apart from slowing down the gait.[9] Our study groups did not differ in the abilities to perform activities of daily living, in the frailty status, in the prevalence of dynapenia, or physical performance (such as gait speed, TUG, and POMA test results). However, this may be due to the specificity of health problems and generally large and complex disability of hospitalized patients in the geriatric ward. They are rather phenotypically similar to the residents of long-term care facilities representing a real challenge for the

Table 3 Comparative Analysis of the Missing Data of Functional and Nutritional Parameters in People with and without Diabetes

Parameter	Missing Data			*P* value[a]
	Total	DM+ Group	DM- Group	
No. (%) of patients	416 (100.0)	126 (30.3)	290 (69.7)	
Barthel Index, n (%)	6 (1.4)	3 (2.4)	3 (1.0)	0.37
IADL, n (%)	10 (2.4)	6 (4.8)	4 (1.4)	0.07
AMTS, n (%)	35 (8.4)	10 (7.9)	25 (8.6)	1.00
GDS, n (%)	52 (12.5)	17 (13.5)	35 (12.1)	0.75
Handgrip strength, n (%)	66 (15.9)	25 (19.8)	41 (14.1)	0.15
Gait speed, n (%)	102 (24.5)	38 (30.2)	64 (22.1)	0.08
POMA, n (%)	94 (22.6)	35 (27.8)	59 (20.3)	0.10
TUG, n (%)	115 (27.6)	37 (29.4)	78 (26.9)	0.63
Falls in the last 12 months, n (%)	58 (13.9)	22 (17.5)	36 (12.4)	0.22
Norton scale, n (%)	6 (1.4)	4 (3.2)	2 (0.7)	0.07
SGPALS, n (%)	6 (1.4)	4 (3.2)	2(0.7)	0.07
BMI, n (%)	62 (14.9)	24 (19.0)	38 (13.1)	0.13
WHR, n (%)	63 (15.1)	23 (18.3)	40 (13.8)	0.30
Waist circumference, n (%)	52 (12.5)	19 (15.1)	33 (11.4)	0.33
MNA-SF, n (%)	12 (2.9)	4 (3.2)	8 (2.8)	0.76
Albumin, n (%)	27 (6.5)	5 (4.0)	22 (7.6)	0.20

Notes: [a]χ^2 test or Fisher exact test, as appropriate, for categorical variables; In all analyses a two-tailed P value of less than 0.05 was regarded as significant.
Abbreviations: AMTS, Abbreviated Mental Test Score; BMI, body mass index; DM, diabetes mellitus; DM+, patients with diabetes; DM-, non-diabetic patients; GDS, Geriatric Depression Scale; IADL, instrumental activities of daily living; MNA-SF, Mini Nutritional Assessment-Short Form; n, number of cases; POMA, Performance Oriented Mobility Assessment; SGPALS, Saltin-Grimby physical activity level scale; TUG, Timed Up and Go Test; WHR, waist hip ratio.

physician. The influence of other than DM risk factors for disability in the advanced and final phase of the disablement continuum may also be crucial and limit the possibility of noticing the impact of this disease on geriatric patients' functional efficiency,[35] but this would require more in-depth analysis. Nevertheless, patients with similar characteristics possess a great challenge for healthcare. Illness complexity should lead to modification of treatment goals and methods of achieving them.[36] The older population with DM is heterogeneous. The disease management should adjust to patients' health and nutritional and functional status.[36–38] It can potentially address the most-relevant outcomes in the older population with DM. This disease is relatively often over-treated,[39] despite the changing guidelines for diabetes care in older adults.[36]

Our study's strength is that we conducted it in a big group of geriatric patients with specific disease profiles who underwent the comprehensive geriatric assessment. Our data were collected during the ward's daily clinical work, which influences study's value. However, our study has got some limitations. First of all, we researched a convenient sample of people admitted to the geriatric ward and not a random sample from the general population. Therefore the results can be generalized for patients of similar settings only. On the other hand, we wanted to check whether the relationship of diabetes with morbidity and disability will be noticeable in geriatric ward patients who constitute an exceptionally burdened population in terms of health. Additionally, as our study was based on the secondary analysis of data previously collected, some pieces of information were limited, as indicated in tables. Although the frequency of missing data did not differ significantly between the DM + and the DM- groups, we cannot rule out that it might have influenced the analysis's final results for at least some assessed functional and nutritional parameters.

Conclusion

As we expected, type 2 DM patients were significantly more often burdened with multimorbidity, polypharmacy, obesity and had an unfavorable profile of cardiovascular diseases than patients without DM. Contrary to our expectations- they did not differ in functional status characteristics. It may result from the specificity of patients hospitalized in the geriatric ward health problems, being in the advanced or final phase of the disablement process.

Abbreviations

AMTS, Abbreviated Mental Test Score; BMI, body mass index; CFS, Clinical Frailty Scale; CKD-EPI, Chronic

Kidney Disease Epidemiology Collaboration; DM, diabetes mellitus; DM+, patients with diabetes; DM-, patients without diabetes; FPG, fasting plasma glucose; GDS, Geriatric Depression Scale; GFR, glomerular filtration rate; HbA_{1C}, glycosylated A_{1C} hemoglobin; IADL, instrumental activities of daily living; IQR, interquartile range; KDOQI, Kidney Disease Outcome Quality Initiative; M, mean; Me, median; MNA-SF, Mini Nutritional Aassessment- Short Form; NYHA, New York Heart Association; OARS, Older Americans Resources and Services; OGTT, oral glucose tolerance test; POMA, Performance Oriented Mobility Assessment; SD, standard deviation; SGPALS, Saltin-Grimby physical activity level scale; TIA, transient ischemic attack; TUG, Timed Up and Go Test; WHO, World Health Organization.

Data Sharing Statement

The data supporting the results in the current study are available from the corresponding author on reasonable request.

Acknowledgments

This study was supported by the Medical University of Bialystok, grant number N/ST/ZB/15/001/3301 (granted to ZBW), and grant number UMB no SUB/3/DN/19/001/3301 (granted to LM). The financial sponsor played no role in the design, execution, analysis, and interpretation of data. The authors appreciate very much the involvement of Dr. Agnieszka Kasiukiewicz in data collection and creating the database in the source study. We presented this paper at the 15th International Congress of the European Geriatric Medicine Society (25–27 September 2019, Krakow, Poland) as a poster presentation with interim findings. The poster's abstract was published in "Poster Abstracts" in European Geriatric Medicine: (https://link.springer.com/content/pdf/10.1007%2Fs41999-019-00221-0.pdf).

Disclosure

The authors report no conflicts of interest in this work.

References

1. Huang ES, Laiteerapong N, Liu JY, John PM, Moffet HH, Karter AJ. Rates of complications and mortality in older patients with diabetes mellitus: the diabetes and aging study. *JAMA Intern Med*. 2014;174(2):251–258. doi:10.1001/jamainternmed.2013.12956
2. Saeedi P, Petersohn I, Salpea P, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: results from the International Diabetes Federation Diabetes Atlas, 9 (th) edition. *Diabetes Res Clin Pract*. 2019;157:107843. doi:10.1016/j.diabres.2019.107843
3. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. *Diabetes Care*. 2004;27(5):1047–1053. doi:10.2337/diacare.27.5.1047
4. Li J, Wang S, Han X, Zhang G, Zhao M, Ma L. Spatiotemporal trends and influence factors of global diabetes prevalence in recent years. *Soc Sci Med*. 2020;256:113062. doi:10.1016/j.socscimed.2020.113062
5. Anton SD, Karabetian C, Naugle K, Buford TW. Obesity and diabetes as accelerators of functional decline: can lifestyle interventions maintain functional status in high risk older adults? *Exp Gerontol*. 2013;48(9):888–897. doi:10.1016/j.exger.2013.06.007
6. Veronese N, Stubbs B, Jackson SE, et al. Prospective associations of cardiovascular disease with physical performance and disability: a longitudinal cohort study in the Osteoarthritis initiative. *Wien Klin Wochenschr*. 2020;132(3–4):73–78. doi:10.1007/s00508-019-01567-y
7. Tabesh M, Shaw JE, Zimmet PZ, et al. Association between type 2 diabetes mellitus and disability: what is the contribution of diabetes risk factors and diabetes complications? *J Diabetes*. 2018;10(9):744–752. doi:10.1111/1753-0407.12659
8. Lazzarini PA, Pacella RE, Armstrong DG, van Netten JJ. Diabetes-related lower-extremity complications are a leading cause of the global burden of disability. *Diabet Med*. 2018;35(9):1297–1299. doi:10.1111/dme.13680
9. da Cruz Anjos DM, de Souza Moreira B, Pereira DS, et al. Impact of type-2 diabetes time since diagnosis on elderly women gait and functional status. *Physiother Res Int*. 2017;22(2):e1651. doi:10.1002/pri.1651
10. Wojszel ZB, Kasiukiewicz A. A retrospective cross-sectional study of type 2 diabetes overtreatment in patients admitted to the geriatric ward. *BMC Geriatr*. 2019;19(1). doi:10.1186/s12877-019-1256-2
11. Franchin A, Corradin ML, Giantin V, et al. Diabetes in a geriatric ward: efficacy and safety of new insulin analogs in very old inpatients. *Aging Clin Exp Res*. 2012;24(3 Suppl):17–19.
12. Wojszel ZB, Kasiukiewicz A, Magnuszewski L. Health and functional determinants of orthostatic hypotension in geriatric ward patients: a retrospective cross sectional cohort study. *J Nutr Health Aging*. 2019;23(6):509–517. doi:10.1007/s12603-019-1201-2
13. Wojszel ZB, Magnuszewski L, Swietek M, Kasiukiewicz A, Swietek ML, Zubrewicz K. Frailty syndrome and functional correlates of atrial fibrillation in patients admitted to the geriatric ward. *Gerontologia Polska*. 2019;27:11–15.
14. Mahoney FI, Barthel DW. Functional evaluation: the Barthel Index. *Md State Med J*. 1965;14:61–65.
15. Fillenbaum GG, Smyer MA. The development, validity, and reliability of the OARS multidimensional functional assessment questionnaire. *J Gerontol*. 1981;36(4):428–434. doi:10.1093/geronj/36.4.428
16. Hodkinson HM. Evaluation of a mental test score for assessment of mental impairment in the elderly. *Age Ageing*. 2012;41(Suppl 3):iii35–iii40.
17. Yesavage JA. Geriatric depression scale. *Psychopharmacol Bull*. 1988;24(4):709–711.
18. Roberts HC, Denison HJ, Martin HJ, et al. A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardised approach. *Age Ageing*. 2011;40(4):423–429. doi:10.1093/ageing/afr051
19. Rockwood K, Song X, MacKnight C, et al. A global clinical measure of fitness and frailty in elderly people. *Can Med Assoc J*. 2005;173(5):489
20. Kaiser MJ, Bauer JM, Ramsch C, et al. Validation of the Mini Nutritional Assessment short-form (MNA-SF): a practical tool for identification of nutritional status. *J Nutr Health Aging*. 2009;13(9):782–788. doi:10.1007/s12603-009-0214-7
21. Tinetti ME. Performance-oriented assessment of mobility problems in elderly patients. *J Am Geriatr Soc*. 1986;34(2):119–126. doi:10.1111/j.1532-5415.1986.tb05480.x
22. Podsiadlo D, Richardson S. The timed "Up & Go": a test of basic functional mobility for frail elderly persons. *J Am Geriatr Soc*. 1991;39(2):142–148. doi:10.1111/j.1532-5415.1991.tb01616.x

23. Rodjer L, Jonsdottir IH, Rosengren A, et al. Self-reported leisure time physical activity: a useful assessment tool in everyday health care. *BMC Public Health*. 2012;12:693. doi:10.1186/1471-2458-12-693
24. Levey AS, Stevens LA, Schmid CH, et al. A new equation to estimate glomerular filtration rate. *Ann Intern Med*. 2009;150 (9):604–612.
25. Araszkiewicz A, Bandurska-Stankiewicz E, Budzyński A; Diabetes Poland. 2019 guidelines on the management of diabetic patients. A position of Diabetes Poland. *Clin Diabetol*. 2019;8(1):1–97. doi:10.5603/DK.2019.0001
26. Rockwood K, Song X, MacKnight C, et al. A global clinical measure of fitness and frailty in elderly people. *CMAJ*. 2005;173(5):489–495. doi:10.1503/cmaj.050051
27. National Institutes of Health. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults–the evidence report. National Institutes of Health. *Obes Res*. 1998;6 (Suppl 2):51s–209s.
28. Johnson LE, Sullivan DH. Malnutrition in older adults. In: Fillit HM, Roskwood K, Young J, editors. *Brocklehurst's Textbook of Geriatric Medicine and Gerontology*. Philadelphia, PA: Elsevier; 2017:914–922.
29. Purnell JQ. Definitions, classification, and epidemiology of obesity. In: Feingold KR, Anawalt B, Boyce A, editors. *Endotext*. South Dartmouth (MA): MDText.com, Inc.Copyright © 2000–2020; 2000.
30. Cruz-Jentoft AJ, Bahat G, Bauer J, et al. Sarcopenia: revised European consensus on definition and diagnosis. *Age Ageing*. 2019;48(1):16–31. doi:10.1093/ageing/afy169
31. Quinones AR, Markwardt S, Botoseneanu A. Diabetes-multimorbidity combinations and disability among middle-aged and older adults. *J Gen Intern Med*. 2019;34(6):944–951. doi:10.1007/s11606-019-04896-w
32. Griffith LE, Gruneir A, Fisher K, et al. Insights on multimorbidity and associated health service use and costs from three population-based studies of older adults in Ontario with diabetes, dementia and stroke. *BMC Health Serv Res*. 2019;19(1):313. doi:10.1186/s12913-019-4149-3
33. Clua-Espuny JL, Gonzalez-Henares MA, Queralt-Tomas MLL, et al. Mortality and cardiovascular complications in older complex chronic patients with type 2 diabetes. *Biomed Res Int*. 2017;2017:6078498. doi:10.1155/2017/6078498
34. Li CL, Chiu YC, Chang HY, Hsu KH, Bai YB, Wang HH. Association of geriatric conditions and cardiovascular diseases with disability in older adults with diabetes: findings from a nationally representative survey. *Geriatr Gerontol Int*. 2013;13(3):563–570. doi:10.1111/j.1447-0594.2012.00935.x
35. Bianchi L, Zuliani G, Volpato S. Physical disability in the elderly with diabetes: epidemiology and mechanisms. *Curr Diab Rep*. 2013;13(6):824–830. doi:10.1007/s11892-013-0424-6
36. Sinclair AJ, Abdelhafiz AH, Forbes A, Munshi M. Evidence-based diabetes care for older people with Type 2 diabetes: a critical review. *Diabet Med*. 2019;36(4):399–413. doi:10.1111/dme.13859
37. American Diabetes A; 12. Older adults: standards of medical care in diabetes-2019. *Diabetes Care*. 2019;42(Suppl 1):S139–S147. doi:10.2337/dc19-S012
38. Longo M, Bellastella G, Maiorino MI, Meier JJ, Esposito K, Giugliano D. Diabetes and aging: from treatment goals to pharmacologic therapy. *Front Endocrinol (Lausanne)*. 2019;10:45. doi:10.3389/fendo.2019.00045
39. Wojszel ZB, Kasiukiewicz A. A retrospective time trend study of diabetes overtreatment in geriatric patients. *Diabetes Metab Syndr Obes*. 2019;12:2023. doi:10.2147/DMSO.S221179