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Dynapenic abdominal obesity is associated with negative clinical outcomes in older patients with type 2 diabetes: a prospective cohort study

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Abstract

Objective: To evaluate the association between dynapenic abdominal obesity (DAO) and the following negative outcomes in older patients with type 2 diabetes (T2D): prolonged length of stay (LOS), readmission within 30 days, in-hospital mortality, and mortality within 1 year after hospital discharge.

Methods: This prospective cohort study included hospitalized older patients with T2D. DAO was defined as a combination of abdominal obesity (high waist circumference [WC]: ≥ 102 cm for men and ≥ 88 cm for women]) and dynapenia (reduced hand grip strength [HGS]: < ≤27 kg for men and < 16 kg for women]). The association between clinical outcomes and DAO was evaluated using multivariate analyses adjusted for confounders. The Kaplan-Meier curve was used to compare 1-year survival in the presence of DAO.

Results: We included 309 patients with T2D (mean age 73.3 ± 6.4 years; 50.5% female; 32.4% with DAO). In multivariate analyses, patients with DAO had a 5.29- and 4.71-fold increase in LOS (≥ 14 days) and 1-year mortality than those without DAO, respectively. Moreover, patients with DAO had a higher risk of 1-year mortality (log-rank test, $p < 0.05$).

Conclusions: Older patients with T2D and DAO are more likely to have prolonged hospitalization and 1-year mortality compared to those without DAO.

Keywords: abdominal obesity; older adults; type 2 diabetes.

INTRODUCTION

Abdominal obesity (AO) and dynapenia are two distinct health conditions related to aging and lifestyle.[1] AO can contribute to decreased muscle strength by the action of inflammatory and endocrine mechanisms that occur due to muscle fat infiltration.[1] Dynapenia is characterized by decreased muscle strength and functionality, mostly in older adults.[2] Individuals with dynapenia have functional limitations that further hinder their performance of basic activities, worsening their quality of life.[3] The combination of dynapenia and AO can better predict functional disability than either condition by itself.[4] Therefore, this recently recognized condition was named dynapenic abdominal obesity (DAO).[5]

DAO is emerging as a major risk factor, as recent studies have shown it to be associated with increased risk of numerous negative outcomes, including fractures[4,5], cognitive impairment,[6] worsening disability, and mortality.[7,8] Moreover, DAO is particularly concerning in patients with type 2 diabetes (T2D), as it can exacerbate the adverse effects associated with diabetes.[1] Isolated OA is a common feature of T2D, and is linked to increased insulin resistance and a higher risk of cardiovascular diseases.[1] Moreover, older patients with T2D often experience a decline in muscle strength owing to poor glycemic control, chronic inflammation, and other metabolic disturbances.[9,10] This reduction in muscle strength – dynapenia – can impair mobility and increase the risk of falls.[11] Thus, DAO can negatively impact the health of older adults with T2D, increasing systemic inflammation and insulin resistance and causing greater difficulty in controlling blood glucose levels.[6-8]

Previous studies in different populations have indicated a relationship between low muscle strength, prolonged hospital stay, and mortality.[12-14] Likewise, in older adults without diabetes, DAO was associated with a higher risk of hospitalization – but not with mortality.[15]

Despite the importance of DAO as a significant health problem, specifically in older people with T2D due to its connection with various adverse clinical outcomes, studies in this group of individuals remain scarce. Thus, this study aimed to assess the association of DAO with the following negative clinical outcomes in hospitalized older patients with T2D: prolonged length of stay (LOS), readmission within 30 days, in-hospital mortality, and mortality within 1 year after hospital discharge.

METHODS

This was the second part of a cohort study that included older individuals with and without T2D.[16] The study protocol was approved by the institutional Research Ethics Committee (opinion #150068) and all participants provided written informed consent, as per the recommendations established by the Declaration of Helsinki.

Participants aged ≥ 60 years with T2D, who had been admitted from July 2015 to December 2017, were considered eligible. Individuals in the intensive care unit, in palliative care, with neurological sequelae, bedbound, and those using enteral nutrition who were unable to communicate or complete the anthropometric measurements were excluded. Figure 1 shows a flow diagram of the patient selection process.

Data were collected within 48 hours of hospital admission at the patient's bedside by a trained researcher using a standardized protocol.

General features, including age and sex, were collected from electronic records. Ethnicity was self-reported by the patient or next of kin upon hospital admission and recorded in participants' electronic medical records. Self-reported smoking and alcohol consumption were prompted by the yes/now questions "Are you a smoker or former smoker?" and "Do you usually consume alcoholic beverages?" Self-reported physical activity was prompted by the question: "Do you practice any physical activity? (yes/no) If so, what activity, how many times a week, and for how long?" Reason for hospitalization and clinical data (such as duration of diabetes, presence of comorbidities, and use of antihyperglycemic agents) were collected from medical records. Disease severity was scored according to the age-adjusted Charlson comorbidity index (CCI).[17] Laboratory measurements (HbA1C, albumin, and C-reactive protein levels) were also collected from medical records.

The participants were weighed and measured within 48 hours of admission by a trained registered dietitian. Body mass index (BMI) was estimated as individuals' weight (kg) divided by their height (cm) squared. BMI was classified according to the WHO criteria[18] as underweight (BMI < 18.5 kg/m^2), normal weight (BMI ≥ 18.5–24.99 kg/m^2), or overweight (BMI ≥ 25 kg/m^2). Malnutrition was evaluated by the Mini Nutritional Assessment Long Form (MNA-LF).[19] The MNA-LF is a specific tool for older adults that consists of 18 components grouped into four aspects: anthropometric data, general status, dietary habits, self-perceived health, and nutritional state.[19] The cutoff points of the MNA-LF classified participants as well-nourished (24–30 points), at risk of malnutrition (17–23.5 points), or malnourished (< 17 points).[19]

Abdominal obesity (AO) was assessed by the waist circumference (WC), measured and recorded in centimeters using a 143 cm long inelastic tape (1 mm resolution), with

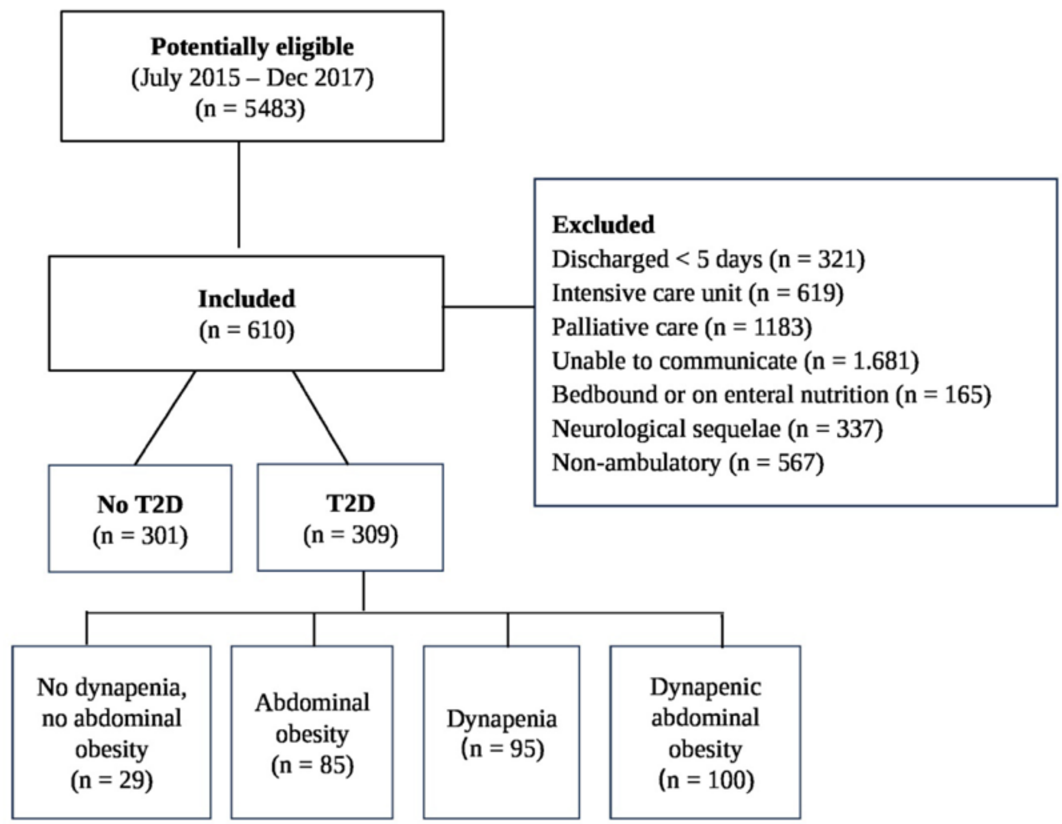


FIGURE 1. Flow diagram of patient selection.

the patient standing upright, at the approximate midpoint between the lower margin of the last rib and the upper bound of the iliac crest. The cut-off points used to classify high WC were ≥ 88 cm for women and ≥ 102 cm for men, as per WHO criteria.[18]

Dynapenia was assessed by handgrip strength (HGS), measured using a hydraulic hand dynamometer (Saehan®) to record the maximum strength patients' non-dominant hand could exert for three seconds. For HGS measurement, patients were instructed to remain seated with their elbows flexed at 90° along the sides of the body. The highest measurement was used for analysis. Values < 16 kg for women and < 27 kg for men were considered as reduced muscle strength, indicating dynapenia.[20]

Dynapenic abdominal obesity (DAO) was defined by the co-occurrence of abdominal obesity (WC ≥ 102 cm for men and ≥ 88 cm for women)[18] and dynapenia (HGS < 27 kg for men and < 16 kg for women).[20]

Cognitive status was assessed in all participants using the Mini-Mental State Examination (MMSE), which yields a score of 0 to 30 points. The cut-off point was set according to educational attainment: < 25 points for those with 1 to 4 years of education; 26.5 for those with 5 to 8 years of education; 28 for those with 9 to 11 years of education; and 29 for those with ≥ 11 years of education.[21]

The length of stay (LOS) was estimated in days from the date of admission to the date of discharge. Prolonged hospitalization (≥ 14 days) was considered according to patients' median LOS. Hospital readmission and mortality data were collected by telephone contact every 3 months with patients or close family members or friends until 1 year after discharge. When telephone contact was not possible, the patient's electronic medical record was consulted. The main causes of mortality were collected from medical records.

This is a secondary analysis of a previously published prospective clinical study of older adults with and without diabetes who had been admitted to a university hospital.[16]

The Kolmogorov–Smirnov test was used to assess the normality of distribution of quantitative variables. Continuous variables are expressed as means ± standard deviations or medians (interquartile ranges) as appropriate;

categorical variables are expressed as absolute (n) and relative (%) frequencies.

For the analysis, participants were divided into four groups by presence or absence of dynapenia (D) and abdominal obesity (AO): Group 1, D (-) /AO (-); Group 2, AO (+); Group 3, D (+); and Group 4, DAO (+). Kruskal–Wallis and ANOVA tests were used as necessary.

Multivariate analyses with 95% confidence intervals (CI) were performed considering the following negative clinical outcomes: LOS ≥ 14 days (categorized by a median of 14 days considering the data distribution in the sample), 1-year hospital readmission (logistic regression), in-hospital mortality, and 1-year mortality (Cox regression). Moreover, independent models were constructed in the multivariate analysis considering negative clinical outcomes as independent predictors. Stepwise regression was used to select the most important covariates based on their contribution to model fit. All models were adjusted for the Charlson comorbidity index (adjusted for age), surgical procedures during hospital stay, time since the diagnosis of diabetes, and the presence of malnutrition.

The Kaplan-Meier curve (log-rank $p < 0.05$) was used to assess the 1-year survival of patients with DAO. All statistical analyses were performed using SPSS, version 25.0 (SPSS Inc., Chicago, IL, USA). Statistical significance was set at $p < 0.05$.

RESULTS

Table 1 describes the general characteristics of hospitalized older patients with T2D. This study included 309 participants with a mean age of 73.3 ± 6.4 years, of whom 50.5% (n = 156) were women and 72% (n = 223) were white. Regarding lifestyle factors, about 14% of participants smoked and consumed alcohol, and 84.8% reported performing no physical activities. The main reason for hospitalization was surgical intervention (29.8%; n = 92). Among clinical and laboratory characteristics, 74.6% of patients had hypertension, with a median duration of diabetes of 10 (2 – 15) years, median HbA1c of 7% (6.4 – 8.5%), and 35.5% (n = 110) were on antihyperglycemic agents. Analysis showed a high CCI adjusted for median age (three points, range one to four), normal albumin values (3.7 mg/dl, range 3.2 to 4.1), and high CRP values (26 mg/dl, range 7.10 – 93).

On nutritional evaluation at hospital admission, mean BMI was 27.9 ± 5.3 kg/m^2; 68.2% of individuals were overweight (BMI ≥ 25 kg/m^2) and 17.8% (n = 55) had malnutrition according to the MNA-LF. In the assessment of abdominal obesity, 78% of patients had high WC, with a

TABLE 1. Characteristics of 309 hospitalized older adults with type 2 diabetes.

Demographic characteristics (%)	
Age (years)	73.3 ± 6.4
Sex (female)	156 (50.5)
Ethnicity/skin color (white)	223 (72)
Behavioral characteristics (%)	
Smoking (yes)	45 (14.6)
Alcohol consumption (yes)	43 (14)
Sedentary lifestyle (yes)	262 (84.8)
Reason for hospitalization (%)	
Surgical intervention	92 (29.8)
Cancer	62 (20)
Liver and bile duct infections	87 (28.1)
Falls	46 (14.8)
Diabetes complications	14 (4.5)
Lung diseases	8 (2.6)
Clinical and laboratory characteristics	
Comorbidities (%)	
Hypertension	232 (74.6)
Cardiovascular disease	42 (19.6)
Duration of diabetes (years)	10 (2 – 15)
HbA1C (%)	7 (6.4 – 8.5)
Antihyperglycemic agents	110 (35.5)
CCI	3 (1 – 4)
Albumin (mg/dL)	3.70 (3.2 – 4.1)
C-reactive protein (mg/dL)	26 (7.10 – 93)
Nutritional parameters (%)	
BMI (kg/m^2)	27.9 ± 5.3
≥ 25 kg/m^2	211 (68.2)
Malnutrition (MNA-LF)	55 (17.8)
Abdominal obesity	
WC, women (cm)	96.6 ± 13.7
WC, men (cm)	98.8 ± 12.5
High WC*	241 (78)
Dynapenia (%)	
HGS, women (kg)	15.6 ± 5.6
HGS, men (kg)	23.7 ± 7.1
Low HGS†	153 (49.5)
Dynapenic abdominal obesity‡	100 (32.4)
Cognition (%)	
Cognitive impairment (MMSE)	78 (25.2)
Negative outcomes (%)	
LOS (days)	14 (8 – 20)
LOS ≥ 14 days	156 (50.5)
One-year hospital readmission	123 (40)
In-hospital mortality	19 (6.1)
One-year mortality	67 (21.7)
Causes of mortality (%)	
Cancer	31 (10)
Sepsis and shock	25 (8.1)
Cardiovascular diseases	21 (6.8)
Generalized complications	9 (3)

HbA1C: Glycated Hemoglobin Test; CCI: Charlson comorbidity index; BMI: body mass index; MNA-LF: mini nutritional assessment long form; WC: waist circumference; HGS: handgrip strength; MMSE: Mini Mental Status Exam; LOS: length of hospital stay.

Data expressed as mean ± standard deviation, median (interquartile range), or n (%).

*High WC: men, ≥102 cm; women, ≥ 88 cm[18]; †Low HGS: men, < 27 kg; women, < 16 kg[20]; ‡Dynapenic abdominal obesity is defined as the combination of high WC and low HGS.

mean of 96.6 ± 13.7 cm in women and 98.8 ± 12.5 cm in men. Mean HGS was 15.6 ± 5.6 kg for women and 23.7 ± 7.1 kg for men. Low HGS, denoting dynapenia, occurred in 49.5% (n = 153) of individuals. Overall, 38.2% of patients were diagnosed with dynapenic abdominal obesity.

Evaluation of cognition by MMSE showed that 25.2% of participants had cognitive impairment. Of the negative outcomes, median LOS was 14 (8 – 20) days, 50.5% of participants remained hospitalized for ≥ 14 days, overall, in-hospital mortality was 6.1%, and 1-year mortality was 21.7%. The main causes of mortality (in-hospital and 1 year after discharge) were cancer (10%), sepsis and shock (8.1%), cardiovascular diseases (6.8%), and generalized complications (3%).

Table 2 shows patients' characteristics stratified by the presence of dynapenia and DAO. Of the 309 older individuals with T2D, 9.38% (n = 29) had no AO or dynapenia but 27.5% (n = 85) had AO; 30.7% (n = 95) had dynapenia; and 32.4% (n = 100) had DAO. AO was more prevalent in women than in men (62%; p = 0.001). Older people with dynapenia had had diabetes for longer than those in other groups (p = 0.004). Regarding nutritional variables, about 45% of individuals with AO had a BMI ≥ 25 kg/m^2. Moreover, 24.5% (n = 23) of individuals with dynapenia had malnutrition according to the MNA-LF.

Table 3 shows the associations of dynapenia and AO with negative clinical outcomes, adjusted for CCI, surgical procedures during hospital stay, time since diagnosis of diabetes, and malnutrition. Older individuals with dynapenia alone and those with DAO had higher odds of LOS ≥ 14 days (odds ratio [OR] = 1.61 [95%CI 1.12 – 3.87] and 2.50 [95%CI 1.05 – 5.95], respectively). Furthermore, older adults with T2D and DAO had a 4.51-fold increased risk of 1-year mortality than older adults with T2D without DAO. Kaplan-Meier survival analysis confirmed this finding (Figure 2).

TABLE 2. Characteristics of 309 older adults hospitalized with type 2 diabetes, stratified by presence of dynapenia and abdominal obesity status.

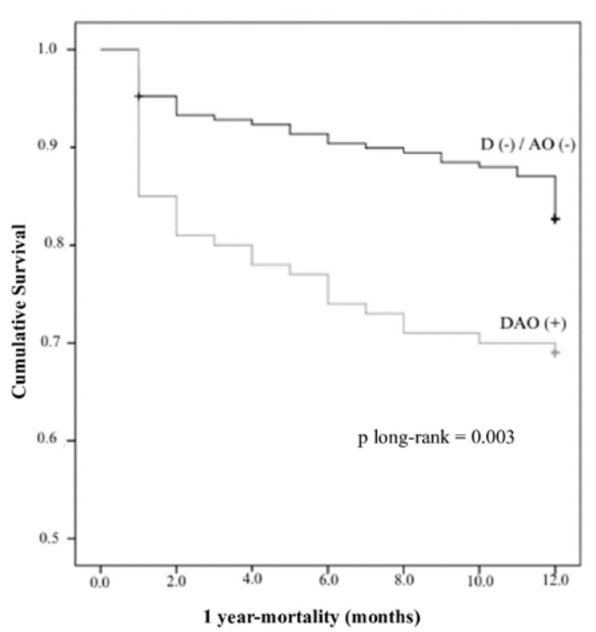
	D (-)/AO (-) (n = 29; 9.38%)	AO (+) (n = 85; 27.5%)	D (+) (n = 95; 30.7%)	DAO (+) (n = 100; 32.4%)
Demographic variables				
Age (years)	74.9 ± 4.4	75.8 ± 4.8	75.6 ± 4.6	75.7 ± 4.6
Sex (female)*	10 (34.4)	59 (69.4)	25 (26.3)	62 (62)
Ethnicity/skin color (white)	20 (69)	64 (75.3)	68 (71.6)	71 (71)
Behavioral variables				
Smoking (yes)	5 (15.2)	15 (17.6)	13 (13.7)	12 (12)
Alcohol consumption (yes)	6 (20.7)	9 (10.6)	14 (14.7)	14 (14)
Sedentary lifestyle (yes)	24 (82.8)	76 (89.4)	80 (84.2)	82 (82)
Clinical conditions				
Surgical procedures (yes)	11 (37.9)	31 (36.5)	30 (31.6)	20 (20)
Hypertension (yes)	22 (66.7)	97 (80.2)	23 (65.7)	89 (75.4)
Duration of diabetes (years)†	1.5 (1 – 10)	5 (1 – 15)	15 (5 – 15)	10 (5 – 12)
HbA1C (%)	7.15 ± 1.83	7.44 ± 1.99	7.59 ± 2.24	7.67 ± 2.11
Albumin (mg/dL)	3.73 ± 0.75	3.72 ± 0.66	3.47 ± 0.54	3.73 ± 0.73
C-reactive protein (mg/dL)	33 (1.4 – 185)	20 (0 – 82.5)	24.4 (1.35 – 59.7)	44.5 (1.90 – 124)
Nutritional evaluation				
BMI (≥ 25 kg/m^2)‡	12 (41.4)	38 (44.7)	23 (24.6)	36 (36)
Malnutrition (MNA-LF)	6 (20)	11 (13)	23 (24.5)	15 (15)
Cognition				
Cognitive impairment (MMSE)	5 (17.2)	18 (21.2)	25 (26.3)	30 (30)
Negative outcomes				
LOS ≥14 days	10 (34.5)	39 (45.9)	54 (56.8)	56 (53)
One-year hospital readmission	12 (41.4)	39 (45.9)	38 (40)	34 (34)
One-year mortality§	3 (10.3)	10 (11.2)	23 (24.2)	31 (31)

D: Dynapenia; AO: Abdominal obesity; DAO: Dynapenic abdominal obesity; HbA1C: Glycated Hemoglobin Test; BMI: Body mass index; MNA-LF: Mini nutritional assessment long form; MMSE: Mini Mental Status Exam; LOS: Length of hospital stay.
Data expressed as mean ± standard deviation, median (interquartile range), or n (%). One-way analysis of variance (ANOVA) was used for continuous variables and the Kruskal-Wallis test for categorical variables. *p = 0.001; †p = 0.004; ‡p < 0.001; §p = 0.006.

TABLE 3. Association of dynapenia and abdominal obesity with negative clinical outcomes: multivariate analysis.

Dependent variables	Prolonged LOS (≥ 14 days)	p-value	One-year hospital readmission	p-value	In-hospital mortality	p-value	One-year mortality	p-value
Independent variables	**OR* (95%CI)**		**OR* (95%CI)**		**HR† (95%CI)**		**HR† (95%CI)**	
D (-)/AO (-) (reference)	1	-	-	-	-	-	-	-
AO (+)	1.79 (0.72 – 4.42)	0.205	1.38 (0.59 – 3.22)	0.44	0.96 (0.33 – 2.80)	0.94	2.87 (0.84 – 9.77)	0.90
D (+)	1.61 (1.12 – 3.87)	0.029	0.86 (0.29 – 2.53)	0.79	1.94 (0.55 – 6.77)	0.29	1.34 (0.36 – 4.99)	0.65
DAO (+)	2.50 (1.05 – 5.95)	0.038	0.98 (0.42 – 2.30)	0.97	1.75 (0.62 – 4.98)	0.46	4.51 (1.35 – 15.36)	0.014

All models of multivariate analysis were adjusted for Charlson comorbidity index, surgical procedure during hospital stay, duration of diabetes, and presence of malnutrition. D: Dynapenia; AO: Abdominal obesity; DAO: Dynapenic abdominal obesity; LOS: length of hospital stay; OR: odds ratio; CI: confidence interval; HR: hazard ratio. *Logistic regression; † Cox regression.



D: Dynapenia; AO: Abdominal obesity; DAO: Dynapenic abdominal obesity.

FIGURE 2. Kaplan-Meier curve of 1-year mortality after hospital discharge, stratified by presence of DAO, in older patients with type 2 diabetes.

DISCUSSION

In this prospective cohort study of 309 older patients with T2D, DAO was significantly associated with 2.5-fold odds of LOS ≥ 14 days and a 4.70-fold higher risk of 1-year mortality after hospital discharge (*vs*. patients without DAO).

The prevalence of dynapenia, AO, and DAO among our participants with T2D was 27.5, 30.7, and 32.4%, respectively. Overall, 50.5% of the sample was female; of these women, 62% were diagnosed with DAO. A cross-sectional study of 20,198 older adults reported similar findings: 54% of that sample comprised women and the prevalence of DAO among them was 74.3%.[22] When we evaluated the main lifestyle factors of our patients, most were overweight (~70%) and sedentary (~85%). It has recently been shown that highly sedentary behavior may increase the risk of DAO in older adults.[22] In fact, sedentariness could potentially reduce muscle strength due to a lack of muscular contractility and other physiological consequences on muscle metabolism (e.g., reduced muscle glucose).[23] This is very useful information for individuals with T2D. However, in our participants there was no association between sedentary lifestyle and DAO. This can be explained by the fact that, despite their sedentarism, patients had reasonably on-target HbA1C levels (median of 7%). Additionally, those with a BMI ≥ 25 kg/m^2 had a higher prevalence of AO (44.7%) and DAO (30%). On the other hand, individuals with dynapenia had a higher prevalence of malnutrition (24.5%). A study of older persons with T2D found a prevalence of dynapenia of approximately 14%, increasing with longer time since diagnosis of diabetes.[10] This study observed a median (IQR) duration of diabetes of 10 (2 – 15) years and significant associations of dynapenia and DAO with time since diagnosis of diabetes ($p < 0.05$).

One of the main findings of this study is the association of dynapenia and DAO with prolonged hospitalization. Older patients with T2D who also had dynapenia or DAO were at 1.61-fold and 2.5-fold higher risk of LOS ≥ 14 days, respectively. Evidence from persons without diabetes corroborates our findings.[12,13] A study carried out with 600 hospitalized individuals found that those with dynapenia had a 1.2-fold increase in their odds of prolonged hospitalization.[12] In a cohort study of 1136 individuals, dynapenia was associated with a LOS of 13 days when compared to those who had no dynapenia, regardless of age, sex, BMI, type of surgery, frailty, and nutritional status.[13] Dynapenia can contribute significantly to LOS.[24] Low muscle strength can limit ability to mobilize early, and lack of mobility can prolong the time needed to regain functional independence and ability to perform the activities of daily living, which can delay hospital discharge.[3,24,25] Moreover, it can increase the risk of falls and injuries during rehabilitation, which can lead to additional complications and further prolong LOS.[26] Indeed, a recent large longitudinal study showed that the presence of dynapenia and DAO accelerated the progression of frailty in older people.[27] Furthermore, the AO component of DAO affects muscle growth and metabolism by increasing the body fat percentage, decreasing muscle strength and muscle mass.[27] In older adults, intramuscular fat accumulation is inversely associated with muscle function.[27]

Another important finding from this study refers to the association between DAO and 1-year mortality after discharge. Older patients with DAO showed a 4.51-fold risk of mortality compared to those without DAO. However, DAO showed no significant association with in-hospital mortality, which could be explained by the relatively low number of deaths during hospitalization (6.1%). The InCHIANTI study evaluated the predictive value of DAO for incident disability, hospitalization, and mortality in 370 older men and 476 older women.[15] After adjustment for potential confounders, the relative risk of death was 1.47 (95%CI 1.09 – 1.97) for dynapenia/DAO when compared to the no-dynapenia/DAO group.[15] The Longitudinal Study of Aging, which involved 7030 participants with an 8-year follow-up, evaluated whether DAO was associated with cardiovascular mortality.[28] Individuals with dynapenia/AO and DAO showed a significantly higher risk of cardiovascular mortality.[28] DAO has also been significantly associated with a higher risk of incident multimorbidity, including diabetes.[29]

This study explored the combined effect of muscle weakness (dynapenia) and AO on adverse clinical outcomes in older adults with T2D.

Some key implications of the results of this study include:

1. Increased risk of prolonged LOS: the association between DAO and prolonged hospital stays suggests that older adults with both conditions may face more severe health complications, leading to longer recovery times and increased healthcare resource utilization;
2. Higher 1-year mortality: the finding that DAO is linked to higher 1-year mortality rates indicates a significant risk factor for premature death. This highlights a critical need for early identification and intervention in this population to improve survival outcomes; and
3. Comprehensive management approaches: our findings underscore the importance of comprehensive management strategies that address both muscle weakness and AO in older adults with T2D.

The analysis of older individuals with T2D and DAO and its association with prolonged hospitalization and mortality within 1 year after hospital discharge are the core strengths of this study. Other aspects may also be interpreted as such. First, the prospective cohort study design allowed us to observe outcomes over time, providing a clearer picture of the temporal relationship between DAO and negative outcomes. Second, we aimed to study a specific, vulnerable population (older adults with T2D), which could encourage further studies on personalized interventions and care strategies. Third, detailed data collection on muscle strength, AO, LOS, and mortality provides a robust dataset for analysis, increasing the reliability of the results. Fourth, the 1-year follow-up period allowed us to assess longer-term outcomes, providing valuable insights into the progression and impact of DAO over time.

Our study also had some limitations. As it was conducted at a single center, its findings may not be generalizable to other settings or populations with different demographic or clinical characteristics. Moreover, despite adjusting for various confounders, some unmeasured factors may have influenced the relationship between dynapenic abdominal obesity and the outcomes of interest. Finally, this study did not provide information on specific interventions that might mitigate the risks associated with DAO, limiting the applicability of its results to clinical practice.

CONCLUSIONS

Older patients with T2D and DAO were more likely to have prolonged hospitalizations and 1-year mortality than those without DAO. However, further research is needed to understand the underlying mechanisms linking DAO with diabetes. The findings of this study stress the importance of addressing both muscle strength and OA in older people with T2D to improve their clinical outcomes.

DECLARATIONS

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Conflict of interest
The authors declare no conflicts of interest.

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Authors' contribution
Mileni Vanti Beretta: conceptualization, formal analysis, investigation, methodology, project administration, resources, writing – original draft. Ticiana da Costa Rodrigues: conceptualization, investigation, methodology, writing – review & editing. Thais Steemburgo: formal analysis, investigation, methodology, resources.

Ethical approval and informed consent
The study protocol was approved by the relevant institutional Research Ethics Committee (approval #150068) and all participants provided written informed consent following the recommendations established by the Declaration of Helsinki.

Data availability statement
The data that support the findings of this study are available from the corresponding author, TS, upon reasonable request.

Reporting standards guidelines
The authors adopted STROBE (Strengthening the Reporting of Observational studies in Epidemiology, https://www.strobe-statement.org/).

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