

ORIGINAL ARTICLE

Clinical-Functional Vulnerability in older people with type 2 Diabetes Mellitus in Amazonas

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Abstract

Introduction: People with diabetes have a greater predisposition to functional decline, which directly impacts quality of life and increases the risk of frailty. The environmental context, especially in remote areas, can amplify or reduce the risk of complications associated with diabetes. Frailty classification is a useful tool for identifying older individuals in vulnerable situations, allowing for the implementation of more effective management strategies. **Objective:** This study aimed to analyze frailty in older individuals with type 2 Diabetes living in the Amazon, through the application of the Clinical-Functional Vulnerability Index-20. **Methods:** This is an observational study, using data from the Primary Health Care Study of the Amazonian Population. Sociodemographic, clinical, functional, and behavioral data were collected in a residential environment. **Results:** The results indicated that age, level of education, number of medications, comorbidities, cognition, chronic pain, difficulties in daily activities, functional disability, and non-adherence to physical activity recommendations are significantly associated with frailty in people with type 2 Diabetes Mellitus ($p < 0.00$). On the other hand, fish consumption did not show a significant correlation with frailty. **Conclusion:** In conclusion, specific factors are

strongly correlated with frailty in older people with type 2 Diabetes Mellitus in the Amazon region, reinforcing the importance of intervention strategies directed at these factors.

Keywords: Health Vulnerability; Frail Elderly; Primary Health Care; Comprehensive Health Care.

Resumo

Vulnerabilidade clínico funcional em pessoas idosas com Diabetes Mellitus tipo 2 no Amazonas

Introdução: Pessoas com diabetes apresentam maior predisposição ao declínio funcional, o que impacta diretamente na qualidade de vida e aumenta o risco de fragilização. O contexto ambiental, especialmente em áreas remotas, pode amplificar ou reduzir o risco de complicações associadas ao diabetes. A classificação da fragilidade é uma ferramenta útil para identificar idosos em situações de vulnerabilidade, permitindo a implementação de estratégias de manejo mais eficazes. **Objetivo:** Este estudo teve como objetivo analisar a fragilidade em pessoas idosas com Diabetes Mellitus tipo 2 residentes no Amazonas, mediante aplicação do Índice de Vulnerabilidade Clínico Funcional-20. **Métodos:** Trata-se de um estudo observacional, utilizando dados do Estudo da Saúde na Atenção Primária da População Amazônica. Foram coletados dados sociodemográficos, clínicos, funcionais e comportamentais em ambiente domiciliar. **Resultados:** Os resultados indicaram que idade, nível de escolaridade, número de medicamentos, comorbidades, cognição, dor crônica, dificuldades nas atividades diárias, incapacidade funcional e nível de atividade física foram significativamente associadas à fragilidade em pessoas com Diabetes Mellitus tipo 2 ($p < 0,00$). **Conclusão:** Conclui-se que fatores sociodemográficos, clínicos, funcionais e comportamentais foram fortemente correlacionados com a fragilidade em idosos com Diabetes Mellitus tipo 2 na região amazônica. **Palavras-chave:** Vulnerabilidade em Saúde; Idoso Fragilizado; Atenção Primária à Saúde; Assistência Integral à Saúde.

Resumen

Vulnerabilidad clínico-funcional en personas mayores con Diabetes Mellitus tipo 2 en el Amazonas

Introducción: Las personas con diabetes presentan una mayor predisposición al deterioro funcional, lo que impacta directamente en la calidad de vida y aumenta el riesgo de fragilidad. El contexto ambiental, especialmente en áreas remotas, puede amplificar o reducir el riesgo de complicaciones asociadas con la diabetes. La clasificación de la fragilidad es una herramienta útil para identificar a los adultos mayores en situaciones de vulnerabilidad, permitiendo la implementación de estrategias de manejo más eficaces. **Objetivo:** Este estudio tuvo como objetivo analizar la fragilidad en personas mayores con Diabetes Mellitus tipo 2 residentes en el Amazonas, mediante la aplicación del Índice de Vulnerabilidad Clínico Funcional-20. **Métodos:** Se trata de un estudio observacional, utilizando datos del Estudio de la Salud en la Atención Primaria de la Población Amazónica. Se recopilaron datos sociodemográficos, clínicos, funcionales y conductuales en el entorno domiciliario. **Resultados:** Los resultados indicaron que la edad, el nivel educativo, el número de medicamentos, las comorbilidades, la cognición, el dolor crónico, las dificultades en las actividades diarias, la incapacidad funcional (SPPB) y la falta de adherencia a las recomendaciones de actividad física están significativamente asociados con la fragilidad en personas con Diabetes Mellitus tipo 2 ($p < 0,00$). Por otro lado, el consumo de pescado no presentó

una correlación significativa con la fragilidad. *Conclusión:* Se concluye que factores específicos están fuertemente correlacionados con la fragilidad en adultos mayores con Diabetes Mellitus tipo 2 en la región amazónica, reforzando la importancia de estrategias de intervención dirigidas a estos factores.

Palabras-clave: Vulnerabilidad en Salud; Anciano Frágil; Atención Primaria de Salud; Atención Integral de Salud.

Introduction

The Brazilian Amazon region has a vast diversity of natural resources, such as fish and fruits factors that could positively influence the health behaviors of the riverine population, especially dietary habits [1]. However, the region's social, economic, and cultural reality, as well as its precarious health and nutrition profile, contrasts with its wealth of natural resources [2]. Social and economic development observed in the North Region has brought about new habits for rural riverine populations, particularly through increased access to market-sourced foods [3]. In areas closer to urban centers, there is greater access to processed foods and products such as sugar and beef [4].

The dietary habits of the riverine population are closely linked to the dynamics of the water cycle (flooding and recession), as agricultural and livestock activities such as raising chickens and cattle may be compromised during periods of high river levels [5]. In this population group, food intake is largely based on manioc flour, accounting for up to 34% of total daily energy intake, and fish, with per capita fish consumption estimated at 550 g/day [4]. Fishing is the foundation of the Amazonian economy. This is evident not only in comparison to other Brazilian regions due to the diversity of species harvested, but also in the quantity of fish captured annually and included in meals, such as tambaqui, pirarucu, pacu, jaraqui, and matrinchã [5].

The level of physical activity in the Amazon population especially in rural and riverine areas is like that of other populations in Brazil [6], with most activity

occurring through travel to and from work and during work itself [7]. Among young people, physical activity is supported through school programs. However, rising physical inactivity due to new social dynamics presents a concerning scenario for future generations in the Amazon [8].

Despite the region's natural potential to promote healthy behaviors, there has been a significant rise in the burden of non-communicable chronic diseases, especially type 2 diabetes mellitus (T2DM) [9]. T2DM is the most prevalent form, accounting for 90–95% of cases, and is most common among adults [10]. The main risk factors are linked to obesity and a sedentary lifestyle [11].

According to SISAB epidemiological data from the first quarter of 2024, 30% of primary healthcare patients in Brazil's North Region are living with diabetes [12]. The presence of T2DM can impact functional capacity and increase the risk of frailty, mainly due to the chronic nature of the disease and associated comorbidities, which may compromise cognitive, visual, auditory, and motor functions. This scenario is especially detrimental to populations that depend largely on subsistence activities, such as riverine communities [13].

Frailty is a multifactorial geriatric syndrome characterized by reduced physiological reserve and resistance to stressors, resulting in increased susceptibility to adverse health outcomes [14]. Risk factors for frailty include multimorbidity, polypharmacy,

muscle mass loss, and cognitive changes, which are particularly common in individuals with chronic conditions such as type 2 diabetes mellitus [15]. Early identification of frailty enables the implementation of personalized interventions focused on functional rehabilitation, promotion of physical activity, and proper management of comorbidities [16]. Instruments such as the Clinical-Functional Vulnerability Index-20 (IVCF-20) have proven

effective for screening and risk stratification of frailty, allowing for more precise healthcare planning [16].

However, few studies have explored the behaviors of the Amazonian population to frailty in the presence of chronic diseases such as T2DM. Therefore, this study aimed to analyze frailty in older adults with type 2 diabetes mellitus living in the state of Amazonas, using the IVCF-20.

Methods

This observational study was conducted using primary data from the Amazon Population Primary Health Care Study (SAPPA) [17]. Data were collected from July 2020 to December 2022 in cities located in the interior of Amazonas (AM), after approval by the Research Ethics Committee of the Federal University of Amazonas, under protocol no. 4.318.325. All participants were informed about the objectives of the study, the procedures involved, and their rights, and signed the Informed Consent Form.

Data collection included municipalities from the metropolitan region of Manaus, Amazonas: Iranduba, Itacoatiara, Manacapuru, Novo Airão, Presidente Figueiredo, Rio Preto da Eva, Silves, and Itapiranga. It also included towns located in the Médio Solimões region, Coari and Alvarães. The study population consisted of individuals diagnosed with T2DM registered at Primary Health Care Units. Participants with communication disorders that made data collection unfeasible were excluded.

To meet the main objective of this study, the IVCF-20 questionnaire was applied. This instrument was developed and validated in Brazil, covering the following dimensions: age, self-perception of health, activities of daily living, cognition, mood, mobility, communication, and the presence of multiple comorbidities [18]. The instrument classifies

individuals as robust older adults (score of 0 to 6), older adults at risk of frailty (score of 7 to 14), and frail older adults (score of 15 or more). The IVCF-20 has a sensitivity of 90.5% and a specificity of 71% for identifying frailty [19].

Sociodemographic data collected included: sex (male/female), age (years), color/ethnicity (White/Asian/Indigenous/Brown/Black), marital status (married/single/divorced/widowed), and educational level. Clinical data included the use of medication for diabetes (yes/no), number of medications, comorbidities (Functional Comorbidity Index – FCI), cognition, duration of diabetes, and chronic pain (self-reported pain lasting more than three months within the last year).

For functional variables, the Brazilian version of the Older Americans Resources and Services Multidimensional Functional Assessment Questionnaire (BOMFAQ) was applied (moderate to severe difficulty / no or mild difficulty), assessing the patient's self-perceived functional capacity. The Short Physical Performance Battery (SPPB) was also used (low or impaired/moderate/good physical capacity), which quantitatively measures physical performance. The cognitive level was assessed using the Mini-Mental State Examination (MMSE; normal/cognitive impairment) [20], and behavioral

data included physical activity level (measured by the International Physical Activity Questionnaire

– IPAQ) [21] and weekly fish consumption. The conceptual model of the study is presented in Figure 1.

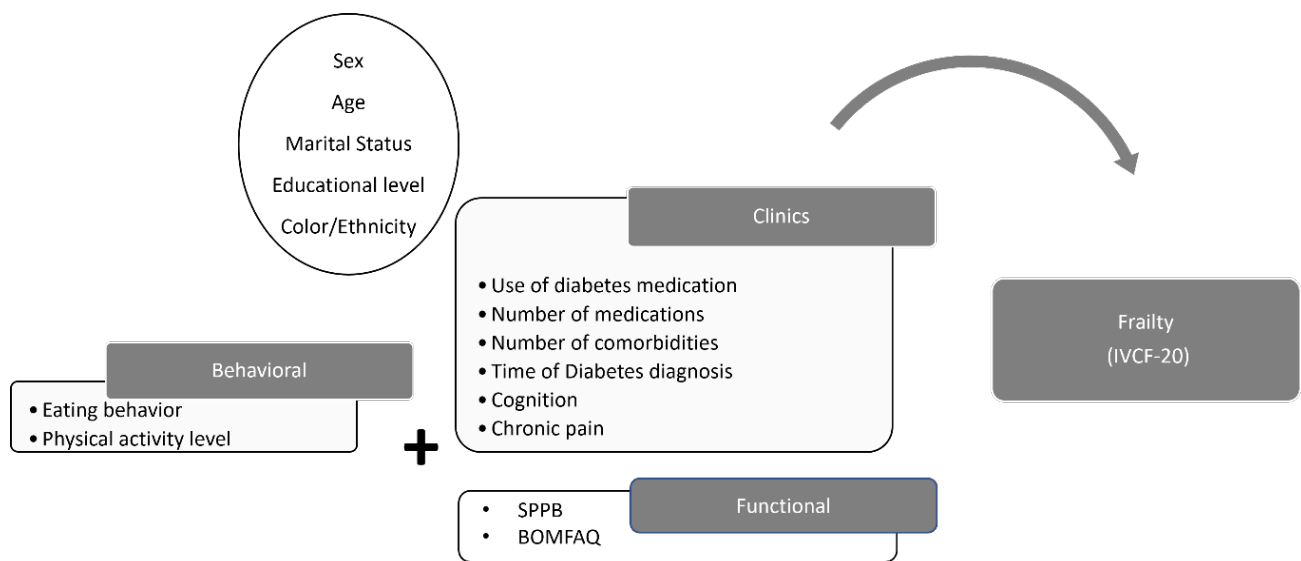


Figure 1 - Conceptual model of study

Statistical analysis was performed using frequency, percentage, mean, and standard deviation descriptions. For inferential analysis, Pearson’s chi-square test was applied to examine associations between categories of

sociodemographic variables, health conditions, and physical activity level with the categories of the IVCF-20 (robust, pre-frail, and frail). The data were analyzed using statistical software SPSS version 24.

Results

Of the 550 participants evaluated, 23.14% (n=128) were classified as robust, 44.12% (n=244) as pre-frail, and 32.19% (n=178) as frail (Table 1). No statistically significant differences were observed in the distribution by sex ($p = 0.284$), color/ethnicity ($p = 0.917$), or marital status ($p = 0.288$) among the groups. Most participants were female and self-identified as mixed color (brown), regardless of frailty classification.

However, significant differences were found in the age groups across the categories ($p < 0.001$). Robust individuals were predominantly between 60 and 69 years old (67.19%; n=86), while frail

participants had a higher proportion in the age group over 80 years (24.16%; n=43). Regarding years of schooling, significant differences were also found ($p < 0.001$). The robust group showed the highest proportion of participants with 6 or more years of education (41.4%; n=53), whereas the frail group was mostly among those with up to 5 years of schooling (80.4%; n=143).

Although diabetes diagnosis duration ($p = 0.181$) and medication use for the condition ($p = 0.394$) did not show significant differences among the groups, the total number of medications used varied significantly ($p < 0.001$). Frail individuals had higher use of

five or more medications (59.8%; n=49), compared to only 3.7% in the robust group (n=3). Additionally, the presence of comorbidities differed significantly between groups ($p < 0.001$). The largest proportion of participants with five or more comorbidities was observed among the frail (67.0%; n=63), while the robust group had a predominance of individuals with one to two comorbidities (30.7%; n=86).

Cognition also showed relevant differences ($p < 0.001$). Most robust individuals maintained normal cognition (57.81%; n=74), while 70.79% of the frail presented cognitive dysfunction (n=126). Regarding chronic pain, its prevalence was significantly higher ($p < 0.001$) in the frail (58.43%; n=104) and pre-frail (40.16%; n=98) groups compared to the robust group (23.44%; n=30)

Table 1 - Sociodemographic and clinical characteristics according to frailty classification (n=550)

Variables	Robust n=128 (23.14%)	Pre-frail n=244 (44.12%)	Frail n=178 (32.19%)	p-value
Sociodemographic data				
Sex				0.284
Female	89 (69.53)	162 (66.4)	131 (73.6)	
Male	39 (30.47)	82 (33.60)	47 (26.40)	
Age group				<0.001
60–69 years	86 (67.19)	134 (54.92)	72 (40.45)	
70–79 years	35 (27.84)	80 (32.79)	63 (35.39)	
>80 years	7 (5.47)	30 (12.29)	43 (24.16)	
Color/ethnicity				0.917
White	21 (16.4)	34 (13.9)	28 (15.7)	
Asian	0 (0)	3 (1.2)	2 (1.1)	
Indigenous	2 (1.6)	2 (0.8)	1 (0.6)	
Brown (mixed color)	95 (74.2)	181 (74.2)	132 (74.2)	
Black	10 (7.8)	24 (9.8)	15 (8.4)	
Marital status				0.288
Married	78 (60.94)	134 (54.92)	91 (51.1)	
Single	16 (12.50)	30 (12.30)	19 (10.7)	
Divorced	9 (7.03)	12 (4.92)	9 (5.1)	
Widowed	25 (19.53)	68 (27.87)	59 (33.1)	
Years of schooling				<0.001
0–5 years	75 (58.6)	182 (74.6)	143 (80.4)	
6 years or more	53 (41.4)	62 (25.4)	35 (19.6)	

Clinical variables			
Duration of diabetes			
1 month–5 years	71 (55.4)	110 (45.1)	85 (47.7)
6–10 years	36 (28.2)	79 (32.4)	47 (26.5)
>11 years	21 (16.4)	55 (22.5)	46 (25.8)
Use of diabetes medication			
Yes	105 (82.1)	207 (84.8)	142 (79.8)
No	23 (17.9)	37 (15.2)	36 (20.2)
Number of medications			
0–2	88 (68.8)	127 (52.0)	91 (38.2)
3–4	37 (28.8)	87 (35.6)	38 (15.9)
>5	3 (2.4)	30 (12.3)	49 (20.6)
Comorbidities			
1–2	86 (67.2)	132 (54.1)	62 (25.0)
3–4	38 (29.7)	85 (34.8)	53 (21.4)
>5	4 (3.1)	27 (11.1)	63 (25.4)
Cognition			
Normal	74 (57.81)	113 (46.34)	52 (29.21)
Dysfunction	54 (42.19)	131 (53.69)	126 (70.79)
Chronic pain			
Yes	30 (23.44)	98 (40.16)	104 (58.43)
No	98 (76.56)	146 (59.84)	74 (41.6)

Caption: Bold numbers indicate significant p-values.

The data analysis illustrated in Figure 2 highlights statistically significant differences ($p < 0.001$) in participants' functional performance, as assessed by the SPPB instrument. The highest proportion of individuals with a disability or low functional capacity was observed in the frail group (52.81%; $n=94$). In contrast, the robust group concentrated the highest

proportion of participants with good functional capacity (48.44%; $n=62$).

Similar results were found in the evaluation using the BOMFAQ scale, also showing statistically significant differences ($p < 0.001$). The frail group exhibited the highest frequency of moderate to severe functional difficulty (52.9%; $n=94$), while

the pre-frail and robust groups recorded 40.9% (n=113) and 6.2% (n=17), respectively, with this level of difficulty.

Regarding behavioral variables, physical activity practice showed significant variation among groups ($p < 0.001$). The frail group had the highest proportion of individuals not meeting physical activity recommendations (37.6%; n=98). Conversely, the robust

group had the highest percentage of participants meeting the recommendations (40.0%; n=62).

Finally, fish consumption did not show statistically significant differences between groups ($p = 0.728$). Most participants reported consuming fish two to three times per week, with this pattern more prevalent in the pre-frail (45.53%; n=111) and frail (41.01%; n=73) groups.

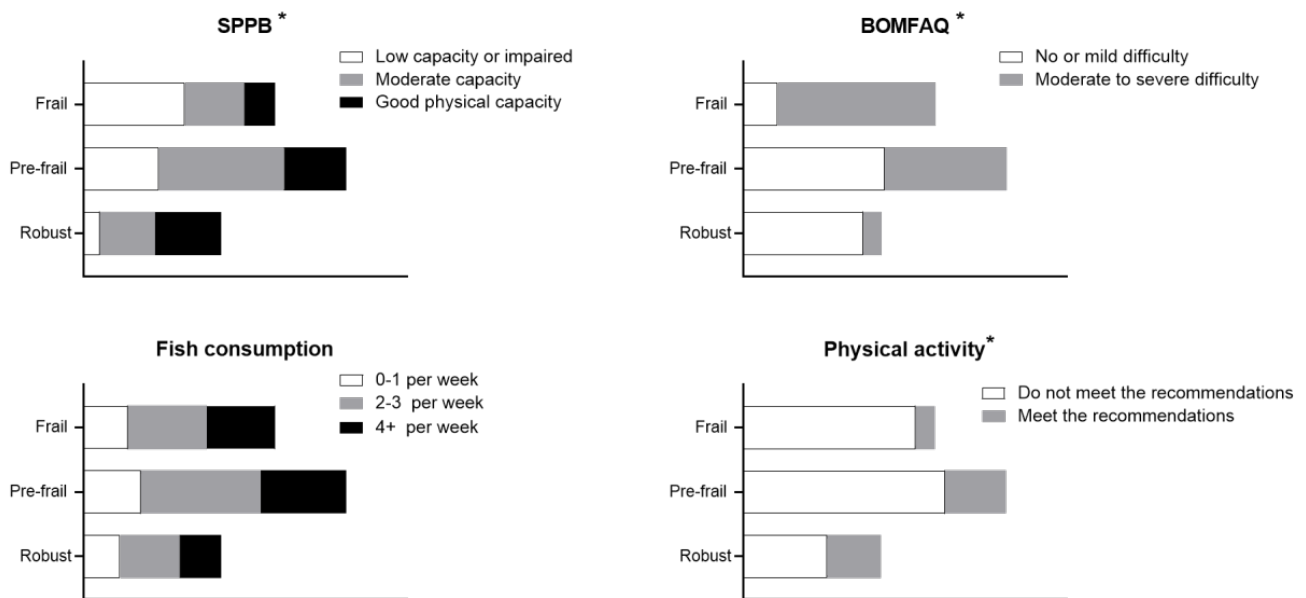


Figure 2 - Association between IVCF-20 categories and functional and behavioral variables * $p < 0.05$

Discussion

This study found a significant prevalence of elderly individuals with T2DM classified as frail, a finding consistent with specialized literature on aging and diabetes. Other studies have reported similar proportions of frailty among elderly people with diabetes, especially in urban contexts where lifestyle habits tend to be less healthy than in rural communities [20]. For this reason, the initial hypothesis of this study was that prevalence would be lower due to the rural context of the population, which was not confirmed. Additionally, studies with samples from primary healthcare in SUS communities

also indicate a lower prevalence of frailty [21], which was not supported by our findings.

Regional studies also contribute to understanding local specificities. For example, a study conducted in Coari (AM), using Fried's frailty phenotype, showed a lower frailty prevalence than the national average for cities with a similar Human Development Index (HDI). This result may be attributed to a slower demographic transition and the Amazonian lifestyle, as well as the fact that many participants had never lived in riverside areas, ensuring greater access to primary healthcare [24].

Although no statistically significant differences regarding sex were observed in this study, there was a female predominance in the frail and pre-frail groups, a finding consistent with the literature [25]. Frailty also showed progression with increasing age, being more prevalent among participants aged 80 years or older. This finding aligns with previous studies identifying age as a significant risk factor for frailty both in individuals with T2DM [27] and in the elderly population in general [28].

The ethnic-racial distribution of the sample reflects the reality of the Northern region of Brazil, with a predominance of people self-identifying as mixed color (*parda*). Although no statistical associations were found between color/ethnicity and frailty in this study, some international research indicates that Black and mixed-color individuals may have higher susceptibility to frailty due to metabolic predispositions associated with insulin resistance [29]. Similarly, marital status was not statistically associated with frailty, although the higher proportion of widowed individuals among the frail supports previous findings suggesting widowhood may exacerbate physical and emotional vulnerability in the elderly [30].

Education level showed a strong association with frailty. Robust individuals tended to have a higher educational level, consistent with other research highlighting the relationship between low education and increased frailty risk, especially among elderly people with T2DM [31]. Although the duration of diabetes diagnosis did not show a statistically significant correlation with frailty status, previous studies emphasize that longer disease duration increases the risk of complications and functional decline [32].

The total number of medications used was significantly higher among the frail, reinforcing findings that suggest polypharmacy may worsen frailty status through side effects or adverse

drug interactions [34,35]. Moreover, comorbidities played a relevant role in frailty characterization, being more numerous among frail participants. This multimorbidity condition, often associated with T2DM, aggravates the risk of functional loss and reduces quality of life [36].

Cognitive dysfunction showed significant differences, with the highest prevalence in the frail elderly group. Recently, the discussion about the role of T2DM in cognitive decline has gained prominence, with some studies pointing to a correlation between hypoglycemic episodes and cognitive decline in frail individuals [22]. Advanced age itself may also contribute to cognitive limitations [23]. The chronic pain criterion showed significant prevalence in the at-risk and frail groups, which reported this condition most frequently. Pain may also be associated with comorbidities and other conditions commonly coexisting with diabetes [24].

Difficulty with daily activities is a crucial indicator in this study, especially considering that elderly riverine populations tend to continue performing activities of daily living (ADL) and instrumental activities of daily living (IADL) even in old age. Data obtained through the BOMFAQ questionnaire reveal that the frail elderly group exhibits the highest level of difficulty in these activities. This finding highlights the relationship between frailty, advanced age, and functional impairment, evidencing the vulnerability of this group in maintaining independence and autonomy in everyday tasks [25].

While the robust elderly group showed a few or only mild difficulties in meeting physical activity recommendations, the at-risk and frail groups did not meet these recommendations. Other studies corroborate this picture, indicating that greater frailty corresponds to a lower ability to adhere to exercise recommendations due to functional loss or cognitive impairments [26,27].

Fish consumption among the population residing in the Northern region is high compared to the national population [28], with one-third of the sample consuming fish four times or more per week. This behavior was also observed in other studies evaluating dietary habits in the Amazonas population [29], where a significant portion reported frequent fish consumption during the week, especially in rural areas of the North [30]. High fish consumption in this study's population showed no statistically significant correlation with frailty status. However, this habit, combined with other aspects of Amazonian life, has been shown to positively influence frailty reduction in elderly individuals in another research [31].

This study has some limitations that should be considered when interpreting the results. First, the sample consisted solely of elderly individuals diagnosed with T2DM residing in specific communities in

Conclusion

The findings of this study highlight a high prevalence of frailty and pre-frailty among elderly individuals with type 2 diabetes mellitus residing in Northern Brazil, with significant associations between frailty and factors such as advanced age, low education, multiple comorbidities, cognitive dysfunction, chronic pain, polypharmacy, and functional impairment. These results reinforce the need for closer attention to this population, particularly regarding early identification of frailty syndrome and implementation of intervention strategies that consider social, clinical, and functional determinants.

Interventions aimed at encouraging physical activity, multidisciplinary monitoring, and adequate management of comorbidities may contribute to preventing frailty progression and promoting quality of life. Considering the Amazonian context with its

Northern Brazil, which may limit the generalizability of findings to other elderly populations with different sociodemographic, cultural, and environmental characteristics. Additionally, data collection excluded individuals with severe cognitive deficits and communication difficulties, which may have underestimated frailty prevalence, given that such conditions are often associated with frailty in older adults.

Finally, despite the use of validated instruments such as the IVCF-20, BOMFAQ, and SPPB, self-reported responses may be subject to recall or social desirability bias, particularly regarding lifestyle habits such as physical activity and dietary intake. Even with these limitations, the results provide relevant contributions to understanding frailty in elderly individuals with T2DM in the Amazon region, highlighting the importance of public health strategies adapted to the local context.

sociocultural and geographic specificities, the importance of targeted public policies and approaches sensitive to local particularities stands out, aiming at comprehensive care for elderly individuals with T2DM and reduction of health inequalities.

Academic affiliation

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Conflict of interest

There are no conflicts of interest.

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Authors contributions

Conception and design of the research: Campos HLM, Leon EB; *Data collection:* Tavares KN, Cardoso MN, Nogueira ES; *Analysis and interpretation of the data:* Tavares KN, Sposito

LAC, Cardoso MN, Nogueira ES; *Writing of the manuscript:* Tavares KN, Sposito LAC, Cardoso MN, Campos HLM, Leon EB; *Critical review of the manuscript for important intellectual content:* Sposito LAC, Campos HLM, Leon EB.

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