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Exploring the association of social connections and food security among adults with uncontrolled type 2 diabetes: a population-based study

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Abstract

Background Primary health care professionals are held accountable for various quality measures in the treatment of patients with chronic diseases such as diabetes. Uncontrolled type 2 diabetes (T2D) remains a considerable health problem; thus, further studying patients with this condition is important for delivering effective interventions. Social determinants of health (SDoH) have been shown to affect various aspects of diabetes care in different subpopulations. We studied the association of SDoH with uncontrolled T2D in a population of adult primary care patients.

Methods We retrospectively searched our electronic health record for adult patients (≥18 years) with a diagnosis of T2D and a hemoglobin A_{1c} (HbA_{1c}) level of 8% or higher. Patients were empaneled to 2 primary care clinic sites between January 1, 2021, and January 31, 2022. Patients were grouped by HbA_{1c} level to stratify patients according to the extent of uncontrolled T2D. Patient characteristics were compared among groups. Unadjusted and adjusted multinomial logistic regression analysis was used to estimate the odds of various SDoH factors among patient groups with different levels of uncontrolled T2D.

Results The study cohort included 1,596 patients. Most patients were White (79%), and the median age was 58.8 years. The median HbA_{1c} level was 8.9%, and approximately 68% of patients were obese (body mass index [BMI] ≥30). When the study population was grouped by HbA_{1c} level (8% to < 9% [$n = 806$], ≥9% to < 12% [$n = 684$], and ≥12% [$n = 106$]), significant differences among groups were observed in age group ($P < .001$), marital status ($P < .001$), race ($P < .001$), ethnicity ($P = .001$), and BMI category ($P = .01$). In groups with higher HbA_{1c} levels, we noticed a higher percentage of patients who were aged 51 to 65 years or single. Among patients with uncontrolled HbA_{1c} levels, more patients were obese than overweight. Patients in the intermediate HbA_{1c} group had increased odds of food insecurity and some decreased social connections, even after adjusting for age, sex, race, ethnicity, and marital status.

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Conclusions Among patients with uncontrolled T2D, higher HbA_{1c} levels were associated with decreased social connections and increased food insecurity. Our findings provide insight into the role of these SDoH in managing T2D and have important implications for primary care practice.

Keywords Food security, Hemoglobin A_{1c}, Primary care, Social connections, Type 2 diabetes, Uncontrolled diabetes

Introduction

In the US, 37 million people have diabetes; in 2019 alone, diabetes was diagnosed in 1.4 million adults 18 years or older [1]. Type 2 diabetes (T2D) constitutes 90–95% of diagnosed diabetes cases. Uncontrolled T2D remains a significant health problem in the US population and is associated with a high mortality rate of up to 13%.[2–4] Complications from uncontrolled T2D are the most common reason for hospitalization among these patients [4].

Quality measures have been developed to ensure high-value care in the US. Health care institutions are held accountable for various quality measures by health care plans such as the Centers for Medicare & Medicaid Services, which is the single largest payer of health care in the US. In addition to hypertension, depression, and preventive care screening, control of T2D is one of the reportable quality measures for patient outcomes [5]. Further examining the characteristics of patients with uncontrolled T2D is important for the delivery of effective interventions in this patient population.

Social determinants are the conditions in which people are born, grow, live, work, and age; they shape the outcomes of disease management and are largely responsible for health inequalities [6]. Social determinants of health (SDoH) such as income, employment, social support, and housing have an effect on glycemic control, low-density lipoprotein levels, and blood pressure to varying degrees in people with T2D [7]. Recognizing the importance of this, the American Diabetes Association published a scientific statement in 2013 about the socioecological determinants that influence the risk of prediabetes and T2D [8].

Further understanding the roles of SDoH is crucial for mitigating their effect on the progression of T2D, the financial strain caused by T2D, and the disproportionate burden of T2D on certain populations [9, 10]. The roles of SDoH as they relate to T2D, its management, and glycemic control have been characterized in various subpopulations [11–13]. However, studies specifically focusing on the association of SDoH with uncontrolled T2D in adults are lacking, with most studies focusing on the general correlation between SDoH and diabetes, regardless of uncontrolled diabetes status [12–14]. Furthermore, the correlation of SDoH with uncontrolled T2D among adults seen for diabetes management in the primary care setting remains unclear.

Here, we retrospectively studied a large cohort of adult patients seen in primary care clinics with varying degrees of uncontrolled T2D based on hemoglobin A_{1c} (HbA_{1c}) levels. In addition to analyzing patient characteristics, we identified factors, specifically SDoH, associated with uncontrolled T2D in this patient population. Although SDoH such as socioeconomic status, education, physical activity, and nutrition have been consistently shown to have a negative association with diabetes control, the roles of other determinants remain unclear [14–16]. Mixed outcomes were observed in the correlation of food security and social connections with uncontrolled T2D. Therefore, we focused specifically on examining the association of food security and social connections with uncontrolled T2D.

Methods

Study setting and design

We retrospectively searched our electronic health record for adult patients (age range, 18–75 years) with a diagnosis of T2D and a most recently determined HbA_{1c} level of 8% or higher who were empaneled to 2 Mayo Clinic primary care clinics (Community Internal Medicine and Family Medicine) between January 1, 2021, and January 31, 2022. We included Mayo Clinic primary care clinics at 6 sites in Rochester ($n=5$) or Kasson ($n=1$), Minnesota: 2 Family Medicine clinics, 1 Community Internal Medicine clinic, and 3 combined Family Medicine/Community Internal Medicine clinics. Only patients who authorized the use of their health records were included in the study; those who declined to have their health record accessed for research purposes were excluded. No patient identifier data were collected. We obtained and analyzed data for patient characteristics (e.g., age, race, ethnicity, marital status, body mass index [BMI] calculated as weight in kilograms divided by height in meters squared), Charlson Comorbidity Index scores, and SDoH. This study was approved by the Mayo Clinic Institutional Review Board, which reviewed all aspects of the study protocol including the protection of patient health information.

Social determinants of health

Patients' responses to questions pertaining to SDoH were captured within the electronic health record. The questions focused on areas of social connections, food security, nutrition history, transportation needs, financial resource strain, physical activity, housing stability, and tobacco use. For this study, we specifically analyzed responses to questions related to housing, food security, social connections, and tobacco use.

Housing stability was assessed with the following 3 questions regarding the past 12 months: (1) "Was there a time when you were not able to pay the mortgage or rent on time?"; (2) "Was there a time when you did not have a steady place to stay or slept in a shelter?"; and (3) "How many places have you lived?"

Food security was assessed with the following 2 statements regarding the past 12 months: (1) "You worried that food would run out before you got the money to buy more"; and (2) "The food you bought just didn't last and you didn't have money to get more."

Social connections were assessed with the following 3 questions: (1) "In a typical week, how many times do you talk on the phone with family, friends, or neighbors?"; (2) "How often do you get together with friends or relatives?"; and (3) "How often do you attend church or religious services?" Patients were also asked if they belong to any club or organization and how often they attend meetings of the club or organization to which they belong.

Tobacco use was assessed with the question, "Within the past 30 days, have you smoked tobacco?"

Table 1 Characteristics of patients

Characteristic	Value[a] (*N* = 1,596)
Sex	
Men	976 (61.2)
Women	620 (38.8)
Age, y	58.8 (49.4–66.0)
Age group, y	
18–30	48 (3.0)
31–50	368 (23.1)
51–65	722 (45.2)
66–75	458 (28.7)
Race	
Asian	74 (4.6)
Black	130 (8.1)
White	1,261 (79.0)
Other[b]	14 (0.9)
Unknown	117 (7.3)
Ethnicity	
Hispanic	102 (6.4)
Non-Hispanic	1,465 (91.8)
Unknown	29 (1.8)
Marital status	
Married/partner	994 (62.3)
Single (unmarried, widowed, divorced)	602 (37.7)
BMI[c] categories	
Underweight (< 18)	4 (0.3)
Normal (18 to < 25)	137 (8.6)
Overweight (25 to < 30)	357 (22.4)
Obese (≥30)	1,092 (68.4)
Unknown	6 (0.4)
Most recent HbA_{1c} result, %	8.9 (8.3–10.1)
Charlson Comorbidity Index score	4 (2–6)

Abbreviations: BMI, body mass index; HbA_{1c}, hemoglobin A_{1c}

[a] Values are reported as median (IQR) or No. (%)

[b] Native American or Pacific Islander

[c] Calculated as weight in kilograms divided by height in meters squared

Statistical analysis

Descriptive statistics were reported for baseline characteristics of patients. The study population was grouped by HbA_{1c} level (8% to <9%, ≥9% to <12%, and ≥12%) to stratify patients according to the level of uncontrolled T2D. The χ^2 test was used to test associations between categorical variables and uncontrolled T2D status. Responses to questions related to SDoH were analyzed and are reported as percentages. Unadjusted and adjusted multinomial logistic regression analysis was used to model the odds of various SDoH factors among patients with uncontrolled HbA_{1c} levels. Results are reported as the odds ratio (95% CI). The initial multinomial model was adjusted for age and sex. The second multinomial model was adjusted for age, sex, race, ethnicity, and marital status to correct for any confounding effects of these variables. *P* values less than 0.05 were considered significant. All statistical analyses were performed using SAS Studio software (version 3.81, Basic Edition; SAS Institute Inc).

Results

A total of 1,596 adult primary care patients were included in the study. Among the study population, 61.2% were men, and most patients were White (79.0%) and non-Hispanic (91.8%) (Table 1). Approximately 45% of patients were in the age bracket of 51 to 65 years. The median (IQR) age of the cohort was 58.8 (49.4–66.0) years, and 62.3% of patients were married or had a partner. Approximately 68% of patients were obese (BMI ≥30). The median (IQR) HbA_{1c} level was 8.9% (8.3-10.1%). The median (IQR) Charlson Comorbidity Index score was 4 (2–6) (Table 1).

When patients were grouped according to HbA_{1c} level (8% to <9% [*n*=806], ≥9% to <12% [*n*=684], and ≥12% [*n*=106]), we observed significant differences among the groups in patient characteristics such as age group (*P*<.001), marital status (*P*<.001), race (*P*<.001), ethnicity (*P*=.001), and BMI category (*P*=.01) (Table 2). We noticed a higher percentage of patients who were 51 to 65 years of age and single in the groups with higher HbA_{1c} levels. Among Hispanic and Black patients, the majority were in higher HbA_{1c} categories. Among all patients with uncontrolled HbA_{1c} levels, more patients were obese than overweight (Table 2).

Most patients (85%) reported not using tobacco in the past 30 days. In response to questions about housing stability in the past 12 months, 82% answered "no" to the questions, "Was there a time when you were not able to pay the mortgage or rent on time?" and "Was there a time

Table 2 Characteristics of patients grouped according to different levels of uncontrolled diabetes

Characteristic	HbA_{1c} group[a]			
	8% to <9% (*n* = 806)	≥9% to <12% (*n* = 684)	≥12% (*n* = 106)	*P* value
Sex				0.09
Men	495 (61.4)	426 (62.3)	55 (51.9)	
Women	311 (38.6)	258 (37.7)	51 (48.1)	
Age, y	61.5 (52.9–67.9)	55.9 (46.9–64.1)	51.8 (39.0–59.0)	
Age group, y				< 0.001
18–30	12 (1.5)	28 (4.1)	8 (7.5)	
31–50	146 (18.1)	184 (26.9)	39 (36.8)	
51–65	355 (44.0)	316 (46.2)	51 (48.1)	
66–75	293 (36.4)	156 (22.8)	8 (7.5)	
Race				< 0.001
Asian	32 (4.0)	33 (4.8)	8 (7.5)	
Black	51 (6.3)	59 (8.6)	20 (18.9)	
White	670 (83.1)	525 (76.8)	67 (63.2)	
Other[b]	4 (0.5)	9 (1.3)	1 (0.9)	
Unknown	49 (6.1)	58 (8.5)	10 (9.4)	
Ethnicity				0.001
Hispanic	35 (4.3)	56 (8.2)	11 (10.4)	
Non-Hispanic	762 (94.5)	614 (89.8)	89 (83.9)	
Unknown	9 (1.1)	14 (2.0)	6 (5.7)	
Marital status				< 0.001
Married/partner	536 (66.5)	416 (60.8)	43 (40.6)	
Single (unmarried, widowed, divorced)	270 (33.5)	268 (39.2)	63 (59.4)	
BMI[c] categories				0.01
Underweight (< 18)	0	1 (0.1)	3 (2.8)	
Normal (18 to < 25)	67 (8.3)	55 (8.0)	15 (14.2)	
Overweight (25 to < 30)	172 (21.3)	161 (23.5)	23 (21.7)	
Obese (≥30)	563 (69.9)	465 (68.0)	65 (61.3)	
Unknown	4 (0.5)	2 (0.3)	0	
Most recent HbA_{1c} result, %	8.3 (8.1–8.6)	9.9 (9.3–10.6)	13.2 (12.4–13.9)	
Charlson Comorbidity Index score	4 (3–6)	3 (2–6)	3 (1–5)	

Abbreviations: BMI, body mass index; HbA_{1c}, hemoglobin A_{1c}

[a] Values are reported as median (IQR) or No. (%)

[b] Native American or Pacific Islander

[c] Calculated as weight in kilograms divided by height in meters squared

when you did not have a steady place to stay or slept in a shelter?" Most patients (89%) reported living in fewer than 2 places.

In response to questions about food security in the past 12 months, 87% responded "never true" to the statement "You were worried that food would run out before you got money to buy more," and 91% responded "never true" to the statement "The food you bought just did not last and you did not have money to get more." 78% of patients did not find it difficult to pay for basic needs such as food, housing, medical care, and heating.

In response to questions about social connections, 66% of patients reported talking on the phone with family, friends, or neighbors 3 or more times a week, and 61% reported getting together with friends or relatives at least once or twice a week. Approximately 40% responded that they never attend church or religious services, whereas 60% attended at least once a year. The majority of patients (64%) reported no affiliation with any group or organization. Among those who belonged to a club or organization, 60% had never attended meetings.

Using a multinomial model adjusted for age and sex, we found increased odds of food insecurity and decreased social connections among patients in groups with higher HbA_{1c} levels (HbA_{1c} ≥9%) (Table 3). Patients in the intermediate HbA_{1c} group (HbA_{1c} ≥9% and <12%) had significantly increased odds of decreased social connections with friends and family members through both telephone communication and social gatherings. Although the findings were not significant, patients in the group with the highest HbA_{1c} level (HbA_{1c} ≥12%) were less likely to attend church or religious services or belong to any club or organization (Table 3).

When we adjusted for age, sex, race, ethnicity, and marital status, results were similar (Table 4). Interestingly, patients in the intermediate HbA_{1c} group (HbA_{1c} ≥9% to <12%) had significantly increased odds of finding it somewhat hard or hard to pay for the very basics like food, housing, medical care, and heating, whereas the group with the highest HbA_{1c} level (≥12%) did not. Likewise, the odds of having decreased social connections with friends and family members through both telephone communication and social gatherings remained significantly increased among this group of patients. Although the findings were not significant, the odds of decreased social connection for most of the questions remained higher for the group with the highest HbA_{1c} level than for the group with the lowest HbA_{1c} level (Table 4).

Discussion

Our study showed a positive correlation between adults with uncontrolled T2D and SDoH, particularly food security and social connections. This observation is not surprising; the results of a systematic review previously showed that social determinants have effects on glycemic and blood pressure control among people with T2D [7]. The odds of food insecurity and decreased social connections were significantly increased among patients in the intermediate HbA_{1c} group (HbA_{1c} ≥9% to <12%), even after adjusting for possible confounding variables. The reason for this is not clear, but other social determinants such as occupation, insurance coverage, and income may have contributed to this finding. Given that the median

Table 3 Odds of SDoH among HbA_{1c} groups, adjusted for age and sex

Question pertaining to SDoH	HbA_{1c}[a]		
	8% to < 9%	≥9% to < 12%	≥12%
Food security			
Within the past 12 months, you worried that your food would run out before you got the money to buy more.			
Never true	Ref	Ref	Ref
Sometimes/often true	Ref	1.34 (0.91–1.97)	1.53 (0.72–3.28)
Within the past 12 months, the food you bought just didn't last and you didn't have money to get more.			
Never true	Ref	Ref	Ref
Sometimes/often true	Ref	1.32 (0.84–2.08)	1.23 (0.48–3.14)
How hard is it for you to pay for the very basics like food, housing, medical care, and heating?			
Somewhat to very hard	Ref	1.43 (1.05–1.95)	1.44 (0.77–2.71)
Not very hard/not hard at all	Ref	Ref	Ref
Social connections			
In a typical week, how many times do you talk on the phone with family, friends, or neighbors?			
Never	Ref	1.69 (0.91–3.12)	0.89 (0.20–4.04)
Once or twice a week	Ref	1.40 (1.07–1.85)	0.98 (0.50–1.93)
Three or more times a week	Ref	Ref	Ref
How often do you get together with friends or relatives?			
Never	Ref	1.88 (1.17–3.02)	2.09 (0.86–5.06)
Once or twice a week	Ref	1.08 (0.81–1.45)	0.72 (0.38–1.37)
Three or more times a week	Ref	Ref	Ref
How often do you attend church or religious services?			
Never	Ref	0.95 (0.72–1.25)	1.23 (0.65–2.31)
At least once per year	Ref	Ref	Ref
Do you belong to any clubs or organizations such as church groups, unions, fraternal or athletic groups, or school groups?			
Yes	Ref	Ref	Ref
No	Ref	1.09 (0.84–1.42)	1.62 (0.86–3.07)
How often do you attend meetings of the clubs or organizations you belong to?			
Never	Ref	1.03 (0.79–1.36)	1.44 (0.77–2.70)
At least 1 time per year	Ref	Ref	Ref

Abbreviations: HbA_{1c}, hemoglobin A_{1c}; Ref, reference group; SDoH, social determinants of health

[a] Data are reported as odds ratio (95% CI)

age of the patients was 58 years, many would have belonged to a working age group whose jobs may have been affected by the social and economic impact of the COVID-19 pandemic, which occurred during the time frame of this study [17].

In our study, poorer diabetes control was associated with increased odds of food insecurity, although this correlation was not statistically significant for most HbA_{1c} groups. However, the odds of having difficulty paying for basics such as food were significantly increased in the intermediate HbA_{1c} group. A previously published meta-analysis found no association between food insecurity and clinically determined diabetes or increased fasting glucose [18]. In contrast, a study of low-income adult patients with poorly controlled diabetes showed that nearly half of the participants reported food insecurity, which was significantly associated with diabetes distress, low medication adherence, and worse glycemic control [19]. In another study, a high rate of food insecurity was identified among patients with both low socioeconomic status and T2D and was likewise associated with less adherence to recommended self-care behaviors, leading to suboptimal glycemic control [20]. Of note, most patients in our study reported no concern with housing. Thus, food insecurity alone may not have a substantial effect on blood sugar control but may become a more significant contributor when combined with other SDoH such as housing and socioeconomic or financial status.

Previously, food insecurity was shown to increase the risk of malnutrition and negatively affect healthy eating behavior in older adults [21, 22]. Notably, our study did not analyze the association between food insecurity and nutrition, which could have indirectly affected diabetes

Table 4 Odds of SDoH among HbA_{1c} groups, adjusted for age, sex, race, ethnicity, and marital status

	HbA_{1c}[a]		
Question pertaining to SDoH	**8% to < 9%**	**≥9% to < 12%**	**≥12%**
Food security			
Within the past 12 months, you worried that your food would run out before you got the money to buy more.			
Never true	Ref	Ref	Ref
Sometimes/often true	Ref	1.23 (0.82–1.85)	1.00 (0.44–2.27)
Within the past 12 months, the food you bought just didn't last and you didn't have money to get more.			
Never true	Ref	Ref	Ref
Sometimes/often true	Ref	1.17 (0.73–1.89)	0.77 (0.29–2.08)
How hard is it for you to pay for the very basics like food, housing, medical care, and heating?			
Somewhat to very hard	Ref	1.42 (1.03–1.94)	1.13 (0.58–2.18)
Not very hard/not hard at all	Ref	Ref	Ref
Social connections			
In a typical week, how many times do you talk on the phone with family, friends, or neighbors?			
Never	Ref	1.59 (0.86–2.96)	0.84 (0.18–3.94)
Once or twice a week	Ref	1.40 (1.06–1.84)	0.91 (0.46–1.81)
Three or more times a week	Ref	Ref	Ref
How often do you get together with friends or relatives?			
Never	Ref	1.87 (1.16–3.01)	2.08 (0.83–5.19)
Once or twice a week	Ref	1.09 (0.81–1.47)	0.78 (0.41–1.52)
Three or more times a week	Ref	Ref	Ref
How often do you attend church or religious services?			
Never	Ref	0.93 (0.71–1.24)	1.14 (0.59–2.21)
At least once per year	Ref	Ref	Ref
Do you belong to any clubs or organizations such as church groups, unions, fraternal or athletic groups, or school groups?			
Yes	Ref	Ref	Ref
No	Ref	1.07 (0.82–1.40)	1.57 (0.82–3.02)
How often do you attend meetings of the clubs or organizations you belong to?			
Never	Ref	1.02 (0.78–1.35)	1.47 (0.77–2.80)
At least 1 time per year	Ref	Ref	Ref

Abbreviations: HbA_{1c}, hemoglobin A_{1c}; Ref, reference group; SDoH, social determinants of health

[a] Data are reported as odds ratio (95% CI)

control, even in a younger cohort. It would be interesting to compare this association among various age groups.

We also observed increased odds of decreased social connections among patients with higher HbA_{1c} levels. Even when we adjusted for age, sex, race, ethnicity, and marital status, those patients were less likely to connect with families, friends, or neighbors. They were also less likely to belong to a social group or organization or attend group meetings. The role of social support in glycemic control among patients with diabetes has been explored in prior studies. Poor social support is associated with reduced glycemic control [23]. Low social support in patients with diabetes also increases the risk of depression, which potentially affects treatment adherence and self-management [24, 25]. Moreover, social isolation and loneliness have been associated with an increased risk of major adverse cardiovascular events in patients with T2D [26]. In contrast, a previous study conducted in a primary care setting did not identify an association between social support and glycemic control in adult patients with T2D [16]. In the current study, we focused on social connections rather than social support; although these may be interconnected, our findings revealed that social engagement and family connections are also social determinants relevant to the control of T2D. A greater focus on ways to promote social connections in this patient population may improve well-being, disease control, and death risk. Whether video calls and other digital interventions enhance social connectedness and reduce loneliness in older adults has been inconclusive [27, 28]. Further studies in other target populations including those with T2D would be helpful.

To our knowledge, we are the first to explore the role of social connections specifically among patients with

poorly controlled T2D in a large cohort. In addition, we examined the association of food insecurity and social connections in subgroups based on HbA_{1c} levels. However, this study had some limitations. First, the study period was during the COVID-19 pandemic when people were practicing social distancing and isolation. Restrictions on social gatherings as part of public safety measures may have introduced bias into the responses regarding social connections. Second, our study focused on the correlation of specific SDoH in adults with uncontrolled T2D; other SDoH that may also contribute to poor diabetes control, such as nutrition, occupation, and income, were not included. Finally, the study population consisted of a fairly homogeneous group of patients served by one academic institution; hence, the results may not be generalizable to other more heterogeneous communities in other geographic locations.

Conclusions

In our cohort with uncontrolled T2D, patients in the intermediate HbA_{1c} group had increased odds of having food insecurity and decreased social connections. Our findings provide insight into the important role that SDoH have in patients with chronic diseases such as diabetes. The positive correlation between decreased social connections and poorer glycemic control has important implications for clinical practice. Given that various types of social communication are available both virtually and in person, providing patients with resources and opportunities to participate in social networks may also empower them to be proactive in promoting their health. On a larger scale, public efforts to create programs that enhance social networking, such as virtual or in-person community-sponsored social events, health fairs, and neighborhood gatherings, should be supported and encouraged.

Abbreviations

BMI	Body mass index
HbA_{1c}	Hemoglobin A_{1c}
SDoH	Social determinants of health
T2D	Type 2 diabetes

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Author contributions

R.S.D. interpreted data and prepared the initial and final drafts of the manuscript; J.A.G. performed statistical analysis and prepared tables; C.F. contributed to the data interpretation and statistical analysis; and J.S.S. contributed to the data interpretation and discussion section. All authors read and approved the final manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

The protocol for the research project has been approved by the Mayo Clinic Institutional Review Board, and it conforms to the provisions of the Declaration of Helsinki (as revised in Fortaleza, Brazil, October 2013). Only records of patients who gave research authorization to have their records accessed were reviewed. No identifiable data were reported.

Consent for publication

The authors consent to the publication of the submitted manuscript.

Competing interests

The authors declare no competing interests.

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