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Association between glycemic control in different emotional conditions and adherence to carbohydrate counting in people with type 1 diabetes during the COVID-19 pandemic in Brazil

Associação entre controle glicêmico em diferentes condições emocionais e adesão à contagem de carboidratos em pessoas com diabetes tipo 1 durante a pandemia de COVID-19 no Brasil

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ABSTRACT

Objective

Evaluate the association between glycemic control in different emotional perceptions and the adherence to carbohydrate counting by adults with type 1 diabetes during the COVID-19 pandemic in Brazil.

Methods

This cross-sectional, descriptive, and analytical study was approved by the Research Ethics Committee (Opinion nº 4,147,663) and conducted in July 2020 using a Google Forms® form. Socioeconomic and demographic data were collected; glycemic monitoring according to the individuals' emotions at the time of measurement (happy, motivated, or hopeful; stressed or

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anxious; sad, distressed, or with depressive symptoms); data on adherence to carbohydrate counting and social distancing. Pearson's Chi-Square test was applied with adjusted residual analysis (p<0.05).

Results

Approximately 64.62% of the 472 participants, had hyperglycemia when stressed/anxious, and 52.97% when they felt sad/distressed/depressive (p<0.000). Associations were observed between having normoglycemia in any emotional situation and performing the carbohydrate counting (p<0.000); perceiving oneself as happy/motivated/hopeful and having hyperglycemia, and not measuring blood glucose was associated with not having the carbohydrate counting (p<0.000); being stressed or anxious was associated with not measuring blood glucose and not having the carbohydrate counting (p<0.000).

Conclusion

The need for multidisciplinary care to enhance mental health and adherence to treatment for people with type 1 diabetes is highlighted.

Keywords: Behavior. Diabetes Mellitus, type 1. Mental health. Social isolation.

RESUMO

Objetivo

O estudo objetivou avaliar a associação entre o controle glicêmico em diferentes percepções emocionais e a adesão à contagem de carboidratos por adultos com diabetes tipo 1 durante a pandemia de COVID-19 no Brasil.

Métodos

Trata-se de um estudo transversal, descritivo e analítico aprovado pelo Comitê de Ética em Pesquisa (Parecer 4.147.663), realizado em julho de 2020 por meio de formulário Google Forms®. Foram coletados dados socioeconômicos e demográficos; monitoramento glicêmico de acordo com as emoções do indivíduo no momento da mensuração (feliz, motivado ou esperançoso; estressado ou ansioso; triste, angustiado ou com sintomas depressivos); dados sobre adesão à contagem de carboidratos e distanciamento social. Aplicou-se o teste qui-quadrado de Pearson com análise residual ajustada (p<0,05).

Resultados

Dos 472 participantes, 64,62% apresentavam hiperglicemia quando estressados/ansiosos, e 52,97%, quando se sentiam tristes/angustiados/depressivos (p<0,000). Foram observadas associações entre ter normoglicemia em qualquer situação emocional e realizar a contagem de carboidratos (p<0,000), perceber-se feliz/motivado/esperançoso e ter hiperglicemia, assim como não medir a glicemia foi associado a não ter a contagem de carboidratos (p<0,000). Estar estressado ou ansioso foi associado a não medir a glicemia e não ter a contagem de carboidratos (p<0,000).

Conclusão

Destaca-se a necessidade de atendimento multidisciplinar para potencializar a saúde mental e a adesão ao tratamento de pessoas com diabetes tipo 1.

Palavras-chave: *Comportamento. Diabetes Mellitus tipo 1. Saúde mental. Isolamento social.*

INTRODUCTION

The pandemic caused by the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) started in late 2019. Older adults, obese, and individuals with comorbidities such as diabetes *Mellitus* (DM) were appointed as a risk group [1]. In the studies by Deng and Peng [2], DM was present in just over 40% of the first 26 deaths from COVID-19 in Wuhan.

Social distancing and other protocols, such as hand hygiene and the use of masks, were recommended [1] to control the spread of COVID-19. However, Chowdhury and Goswani [3] mention that distancing measures can adversely affect the glycemic control of patients with Type 1 Diabetes *Mellitus* (T1DM) due to restrictions on outdoor physical activities, psychological issues, deregulated sleep, and the intake of unhealthy foods.

Blood glucose monitoring and a balanced diet are some of the pillars of T1DM treatment. Blood glucose monitoring is essential to avoid uncontrolled blood glucose, and with technological advances, new methods, such as capillary blood glucose self-monitoring, help in this procedure [4]. According to Ebekozien et al. [5], the increased risk of complications from COVID-19 may be related to the deficient glycemic control.

Regarding food, Carbohydrate Counting (CC) is a strategy that aims to improve the quality of life of individuals with T1DM, as it allows flexibility in eating habits [6]. It estimates the amount of carbohydrates consumed in meals and adjusts insulin therapy accordingly. Multidisciplinary monitoring is required, including a nutritionist, to elaborate an individualized dietary plan [6].

Nogueira et al. [7] argue that the disease's complications can compromise the individuals' biopsychosocial conditions if there is low adherence to the treatment of T1DM. Victório et al. [8] affirm that emotional reactions in people with DM are essential aspects and have more significant variations associated with the disease. Furthermore, addressing DM peculiarities can trigger positive or negative emotions depending on the engagement process. Thus, when evaluating adolescents with T1DM, the authors mention that improved treatment adherence and, consequently, better glycemic control and better quality of individuals' lives [8] can be achieved through better regulation of emotion, thoughts, and behavior, addressing stressors adaptively.

The limited number of studies that relate "emotional aspects" and "Carbohydrate count" in individuals with DM1 implies a lack of methodological tools that jointly assess these parameters. Moreover, the uniqueness of this article is contributing to filling this gap and subsidizing the future use of tools that help people with DM1 identify feelings and their influence on blood glucose, following trails of attention and care to comprehensive health from studies that consider biopsychosocial-cultural variables.

Therefore, considering that the treatment of T1DM and the recommended social distancing to prevent the spread of COVID-19 can influence the mental health and behavior of individuals, and the scarcity of studies that assess emotional aspects and CC in individuals with T1DM during the COVID-19 pandemic, the present study aims to assess the association between blood glucose control in different emotional aspects and adherence to CC in people with T1DM during the COVID-19 quarantine in Brazil.

METHODS

This cross-sectional, descriptive, and analytical study was conducted in July 2020, and refers to the time bracket in which measures of social distancing were in force in the Brazilian territory to combat the COVID-19 pandemic. An online form was employed via the Google Forms® platform to perform the study.

Individuals of both genders, over 18, diagnosed with T1DM, voluntarily, anonymously, and in agreement with the Informed Consent Form (ICF) – presented at the beginning of the online form – participated in the research. Non-probabilistic convenience sampling was performed. After agreeing to the ICF, the participants selected their current condition (with T1DM, not having diabetes, other types of diabetes, child/adolescent, or caregiver), and if the answer disagreed with the expected audience, the research was automatically terminated, thus avoiding the possibility of other audiences responding to the survey. The survey closed automatically, and participants were excluded when they marked any of the following alternatives: being legally responsible for a minor

with diabetes; being a child/adolescent with type 1 diabetes; having type 2 diabetes; having diabetes of another type (gestational, LADA, and MODY); having diabetes, but not knowing which type; or not fitting into any of the options presented. Participants who reported being younger than 18 and older than 59 and adults with T1DM who did not complete the survey or disagreed with the ICF were also excluded. A total of 576 people responded to the questionnaire, and only 472 met the inclusion criteria.

Data was collected via Google Forms® using the opinion survey format per Resolution nº 510 of April 7, 2016 [9]. Through the social networks of an Extension Project linked to a Federal University, participants were selected online invitations on Facebook®, Instagram®, and WhatsApp®, widely publicized in social media networks directly to people who claimed to have T1DM in their social media biography. The research link was sent with a message that specified that the research was directed at people with T1DM and over 18. The research was divided into five axes:

– Socioeconomic and demographic data: gender, age, household income (considering the Brazilian minimum wage value in 2020 of 1,039.00 BRL) – education – "without higher education" and "with higher education"; macro-region (North, Northeast, Midwest, Southeast, and South);

– The technology used to monitor blood glucose: glucometer system; Flash glycemic monitoring system; Flash glycemic monitoring system and glucometer system; did not perform monitoring;

– Blood glucose monitoring concerning the emotions of individuals at the time of measurement: The classification of emotions was described in each of the questions to assess this axis; (a) being HAPPY ("smiling, willing to interact and perform daily tasks), MOTIVATED (started some new activity, for example) or HOPEFUL (thinking that you will soon have a vaccine, and the curve of infection and deaths will reduce); (b) being STRESSED (easily irritated, yelled at people in my house for no reason, had excessive hair loss) or ANXIOUS (tachycardia without clinical cause, excessive sweating, hand tremors; (c) being SAD (feeling like crying, unwilling to carry out daily activities), ANGUISHED (thinking about the difficulties facing the pandemic, tightness in your chest for no medical reason, suffocation), or having DEPRESSIVE SYMPTOMS (crying for no reason apparent insomnia, lack of appetite). The following alternatives were available for each condition: "Hypoglycemia (0 to 69mg/dl)", "Normoglycemia (70 to 180 mg/dl)", "Hyperglycemia (above 180mg/dl)", "I was unable to inform because they had not measured it, despite having the necessary inputs for the measurement" and "they did not know the information, as they did not have the inputs";

– Food regarding adherence to Carbohydrate Counting: "They did not know what carbohydrate counting was"; "They knew, but did not know how to do it"; "They knew how to do it, but they did not do it"; "stopped counting"; "they do it at the same frequency as before the social distancing"; "they do it less frequently than before the pandemic";

– Social distancing: type of distancing (total, who was not leaving home for any activity; partial, going out only to buy food or medicine; they were not distancing because they worked outside the home; they were not distancing themselves because they did not agree; they did not agree with social distancing, but respected it for family reasons).

The IBM®SPSS® software, version 21.0 software was used for statistical analysis. Descriptive results were expressed as proportion and absolute frequency. For statistical analysis, the variable "carbohydrate count" categories were grouped for classification purposes into "performed" or "did not perform", regardless of the reason. The simple Chi-Square test was applied for descriptive

analyses, checking for differences between the categories of analysis, and in the analytical part, the association was tested using Pearson's Chi-Square test with adjusted residual analysis, considering the significance level statistic of $p<0.05$.

This research was approved by the Research Ethics Committee (Opinion n° 4.047.909). All respondents agreed to participate in the survey by selecting "I read the consent form and accept to participate in the survey" before completing the form. A link made the consent form available for reading. People who selected the option "I do not accept to participate in the survey" were automatically excluded.

RESULTS

A total of 472 adults with T1DM whose mean age was 30.24±9.74 years were evaluated. Most ($p<0.001$) were female (86.02%), had an income of 3 to 5 minimum wages (32.42%), had no higher education (76.27%), lived in the Southeast (47.03%), and were in partial social distancing (65.68%) (Table 1).

Regarding the technology used to monitor blood glucose, 72.88% ($p<0.000$) of the participants used the glucometer. When the emotions were evaluated when measuring blood glucose, we observed that 70.55% ($p<0.000$) of the participants were normoglycemic when they were happy, motivated, or hopeful; most had hyperglycemia when stressed or anxious (64.62%; $p<0.000$) and when they felt sad, distressed or with depressive symptoms (52.97%; $p<0.000$) (Table 2).

Table 1 – Characterization of sample and type of social distancing of people with type 1 diabetes during the COVID-19 pandemic in Brazil, 2020. (n=472).

Variables	Mean	Standard deviation	*p*-value*
Age	30.24	9.74	-
Sex			
Female	406	86.02	<0.000
Male	66	13.98	
Household income (MW)			
<1	19	4.03	<0.000
1 – 2	134	28.39	
3 - ≤5	153	32.42	
>5 - ≤10	103	21.82	
>10 - ≤20	46	9.75	
>20	17	3.60	
Education			
Without higher education	112	23.73	<0.000
With higher education	360	76.27	
Macro-region			
North	33	6.99	<0.000
Northeast	97	20.55	
Midwest	37	7.84	
Southeast	222	47.03	
South	83	17.58	
Distancing type			
Total	89	18.86	<0.000
Partial	310	65.68	
Did not perform because they needed to work	67	14.19	
Did not perform because they disagreed	1	0.21	
Were distant for family reasons. despite not agreeing	5	1.06	

Note: *Chi-square.

Table 2 – Characterization of blood glucose monitoring in different emotional conditions of people with type 1 diabetes during the COVID-19 pandemic in Brazil, 2020. (n=472).

Variables	n	%	*p*-value*
Technology used to monitor blood glucose			
Glucometer	344	72.88	<0.000
Flash glycemic monitoring system	18	3.81	
Flash glycemic monitoring and glucometer system	106	22.46	
Did not perform monitoring	4	0.85	
Blood glucose and emotions			
When happy, motivated, or hopeful			
Hypoglycemia	16	3.39	<0.000
Normoglycemia	333	70.55	
Hyperglycemia	82	17.37	
Did not have measured	31	6.57	
Did not know how to inform, as they did not have the inputs	10	2.12	
When stressed or anxious			
Hypoglycemia	35	7.42	<0.000
Normoglycemia	97	20.55	
Hyperglycemia	305	64.62	
Did not have measured	25	5.30	
Did not know how to inform, as they did not have the inputs	10	2.12	
When sad, distressed, or with depressive symptoms			
Hypoglycemia	46	9.75	<0.000
Normoglycemia	128	27.12	
Hyperglycemia	250	52.97	
Did not have measured	39	8.26	
Did not know how to inform as they did not have the inputs	9	1.91	

Note: *Chi-square.

Concerning adherence to the CC strategy, 37.71% reported adhering at the same frequency as before the pandemic; 20.13% were performing it more frequently; 18.01% knew what it was, but did not know how to do it; 13.77% knew how to do it, but did not do it; 5.08% reported doing it less frequently than before; 2.97% had stopped doing the CC during the social distancing; and 2.33% did not know what it was.

We observed that having normoglycemia when they perceived themselves to be happy, motivated, or hopeful was associated with performing the CC, and having hyperglycemia in this emotional condition, not knowing how to inform because they had not measured even with the necessary inputs or for not having the inputs, was associated with not performing CC (p<0.000) (Table 3).

Regarding glycemic control when stressed or anxious, we observed that having normoglycemia in these emotional conditions was associated with performing CC. Not knowing how to inform about glycemic control, with or without monitoring inputs, was associated with not performing CC (p<0.000) (Table 3).

As for glycemic control, when one felt sad, distressed, or with depressive symptoms, having normoglycemia in these emotional conditions was associated with performing the CC, while not knowing how to inform about glycemic control due to the lack of necessary inputs was associated with not performing the CC (p<0.000) (Table 3).

Table 3 – Association between the blood glucose in different emotional conditions and adherence to Carbohydrate Counting of people with type 1 diabetes during the COVID-19 pandemic in Brazil, 2020. (n=472)..

Variables	Carbohydrate Counting				*p*-value*
	Did not perform		Perform		
	n	%	n	%	
When happy, motivated, or hopeful					
Hypoglycemia	7	1.48	9	1.91	<0.000
Normoglycemia	93	19.70(-)	240	50.85(+)	
Hyperglycemia	46	9.75(+)	36	7.63(-)	
Did not have measured	21	4.45(+)	10	2.12(-)	
Did not know how to inform, as they did not have the inputs	8	1.69(+)	2	0.42(-)	
When stressed or anxious					
Hypoglycemia	16	3.39	19	4.03	<0.000
Normoglycemia	24	5.08(-)	73	15.47(+)	
Hyperglycemia	112	23.73	193	40.89	
Did not have measured	15	3.18(+)	10	2.12(-)	
Did not know how to inform, as they did not have the inputs	8	1.69(+)	2	0.42(-)	
When sad, distressed, or with depressive symptoms					
Hypoglycemia	15	3.18	31	6.57	<0.000
Normoglycemia	30	6.36(-)	98	20.76(+)	
Hyperglycemia	101	21.40	149	31.57	
Did not have measured	22	4.66	17	3.60	
Did not know how to inform, as they did not have the inputs	7	1.48(+)	2	0.42(-)	

Note: *Chi-square. Residual analysis: (+)Significant association; (-)Negative significant association.

DISCUSSION

The present study evaluated the association between glycemic control in different emotional conditions and adherence to CC in people with T1DM during quarantine by COVID-19 in Brazil. We identified a mean age of 30.24±9.74 years, most were female, had a household income from three to five minimum wages, had no higher education, lived in the Brazilian Southeast, and were performing partial social distancing. In the study by Barone et al. [10], the authors aimed to identify the main obstacles faced by people living with diabetes in Brazil during the COVID-19 pandemic. They observed that 70.78% of the 1,701 participants with T1DM were between 18 and 50, 75.54% were female, and 64.96% of respondents were from the Brazilian Southeast, data that corroborates those found in this study.

As for household income, most stated that they had from three to five minimum wages and lived in their respective state's capital. These results are similar to those found in the studies by Barone et al. [10] and Melo et al. [11], who showed that most people with T1DM in Brazil reside in capitals and have a low or medium socioeconomic level.

Regarding the technology used for blood glucose monitoring, it was observed that most used the glucometer. This equipment has the lowest cost among other possible devices to measure blood glucose, allows the upload of information and, therefore, the graphic analysis of blood glucose levels measured by patients, which contributes to a better interpretation of the individual reality by health professionals [6].

Other advanced technologies, such as the flash glycemic monitoring system, are already used [6]. However, their high acquisition and maintenance costs can hinder its purchase by some individuals with T1DM. Thus, it is essential to encourage public policies to assist more patients in acquiring new technologies and secure their maintenance, thus streamlining treatment adherence and glycemic control.

Regarding emotional aspects, we observed that most had normoglycemia when they were happy, motivated, or hopeful; and hyperglycemia was predominant when participants were stressed or anxious, and when they felt distressed or with depressive symptoms. In this context, Kalra et al. [12] mention that the imbalanced emotional condition in people with T1DM may be associated with a lack of glycemic control.

As for the adherence to the CC, we observed that most participants performed the CC at a higher or the same frequency than before social distancing. We did not identify other studies that assessed adherence to the CC during social distancing; however, according to Mesa et al. [13], daily activities in a safe home environment could facilitate glycemic control due to increased consumption of homemade food, adherence to CC and insulin administration, reduced workload, and increased time to address the DM demands.

The CC is an essential strategy in treating patients with type 1 diabetes, aimed at balancing blood glucose levels, the amount of carbohydrates in meals, and the amount of bolus insulin to be applied, which is why CC allows patients to adjust the amount of carbohydrates consumed according to their food preferences without compromising glycemic control. Glycemic self-monitoring and insulin administration should be performed regularly for adherence to CC. These procedures require supplies (glucometers, lancets, test strips) and devices for insulin administration. The availability of these supplies is crucial for patients with T1DM to successfully perform CC and maintain adequate glycemic control [6]. While the literature already shows some difficulties associated with adherence to CC, there is still a lack of studies that analyze the perception of people with T1DM and relate this behavior to different emotional conditions.

It was observed that, in all emotional conditions, having normoglycemia was associated with performing the CC, which is a strategy that streamlines glycemic control by favoring the flexibility of food choices to preserve the balance between the blood glucose value, the amount of carbohydrates ingested and the amount of applicable insulin [6,14]. We could not identify any study that assessed adherence to CC by individuals with T1DM in different emotional conditions before or during the pandemic. However, based on the results of the present study, it is suggested that CC, in any emotional state, can help glycemic control.

In the study by Fortin et al. [15] conducted before the pandemic, among the evaluated participants, those who had a history of depression or depressive symptoms at the time of the survey reported difficulties in adhering to CC, when compared to those without the disease (33% vs. 11% p=0.01). However, the sample profile differs from the present study, where participants were evaluated regarding the perception of emotional conditions and not with a diagnosis of depression or other psychiatric illness, which may explain the difference in the results found.

Moreover, not measuring blood glucose because they did not have the necessary inputs was associated with not performing CC in all emotional conditions. Individuals must have all the necessary inputs for glycemic measuring [6,14] to adhere to CC. However, in the study by Barone et al. [10], the authors mention that, although the federal government and some Brazilian states implemented strategic plans during the COVID-19 pandemic to ensure the distribution of medicines and medical supplies for 90 days to individuals living with DM or others chronic diseases, the authors noted that the measures did not cover most of this population.

It was also observed that, when people perceived themselves as happy/motivated or stressed/anxious, hyperglycemia was associated with not performing the CC and not measuring blood glucose. In the study by Fortin et al. [15], the authors mention that it is necessary to have knowledge, discipline,

and precision to perform the CC, which implies the identification of foods containing carbohydrates, estimating portion sizes, and labeling reading. Therefore, they require skills with a high degree of complexity. Our hypothesis suggests that individuals may not feel motivated to pause daily tasks for self-care related to DM since they require available time when in extreme emotional situations (happy or stressed, for example).

A limitation of the study is the online nature of the research, which excludes people who need internet access. Furthermore, the geographic distribution of participants limited a representative sample. There is still a shortage of studies that explore the impacts of the new coronavirus pandemic on the adherence to treatment of people with T1DM, which shows the need for further studies to detail the context in which behaviors mediated by emotional aspects are emitted more accurately.

It also highlights the importance of studies that investigate these factors longitudinally, in more extensive displays, to clarify the affinity of emotional aspects in CC better. Furthermore, knowing that patients with DM1 require a more comprehensive follow-up, requiring the active participation of psychology and psychiatry professionals to observe behavioral changes that will affect adherence to the CC and eating habits, also considering that this care can assist in the syndrome of feelings and behaviors so that this patient can prevent feelings from affecting blood glucose and, thus, avoid the deterioration of symptoms of psychopathological conditions, failures in the adherence to treatment, and micro and macrovascular complications.

CONCLUSION

Associations were observed associations in all emotional conditions, between having normoglycemia and performing the CC, and not measuring blood glucose because they did not have the necessary supplies was associated with not performing CC. However, when participants perceived themselves as happy, motivated, or hopeful, having hyperglycemia and not measuring blood glucose was associated with not performing the CC, and perceiving oneself as stressed or anxious was associated with not measuring blood glucose and not performing CC.

This study brings unprecedented results on the association between glycemic control in different emotional aspects and adherence to CC in people with T1DM during the COVID-19 pandemic in Brazil. The need to encourage CC is highlighted as a way to make the dietary routine more flexible, enhancing patients' autonomy, and we underscore the relevance of multidisciplinary care to promote mental health, crucial for people with T1DM adherence to treatment.

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CONTRIBUTORS

VR VIANA and JLD KIKUCHI was responsible for the project development, manuscript writing/editing, review and editing. MML CARVALHAL and DL GOMES was responsible for the supervision, conceptualization, data collection or management, data analysis, Manuscript writing/editing, review and editing. KM FELÍCIO contributed to the project development, manuscript writing/editing.