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Effectiveness of cinnamon in the reduction of lipid levels in people with diabetes: a randomized clinical trial

Efetividade da canela na redução de níveis lipídicos em pessoas com diabetes: ensaio clínico aleatorizado

Eficacia de la canela en la reducción de los niveles de lípidos en personas con diabetes: un ensayo clínico aleatorizado

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ABSTRACT

Objective: To evaluate the effectiveness of cinnamon in reducing lipid levels in people with diabetes.

Method: Randomized clinical trial of parallel groups, triple-blind, conducted in Basic Health Units in the state of Piauí in 2019. People with Type 2 Diabetes Mellitus, between 18 and 80 years old, using oral antidiabetics, were included, and divided into two groups. The experimental group tested 3g of cinnamon for 90 days.

Results: 140 people participated in the study. From these, the experimental group (n= 71) showed a reduction in mean levels of total cholesterol (p= 0.316 | CI 95% -24.9-8.1), LDL (p= 0.024 | CI 95% -29.3 -2.1) and triglycerides (p= 0.969 | 95% CI -28.6-27.5), and increased HDL (p= 0.001 | 95% CI 4.2-10.2).

Conclusion: The use of 3g of cinnamon per day, for 90 days, seems to help reduce LDL values and increase HDL levels in patients with diabetes.

Descriptors: Cinnamomum zeylanicum. Diabetes Mellitus, type 2. Lipids. Clinical trial.

RESUMO

Objetivo: Avaliar a efetividade da canela na redução dos níveis lipídicos em pessoas com diabetes.

Método: Ensaio clínico aleatorizado de grupos paralelos, triplo cego, realizado em Unidades Básicas de Saúde do estado do Piauí em 2019. Foram incluídas pessoas com Diabetes Mellitus tipo 2, entre 18 e 80 anos, em uso de antidiabéticos orais, e divididos em dois grupos. No grupo experimental testou-se 3g de canela por 90 dias.

Resultados: 140 pessoas participaram do estudo. Destas, o grupo experimental (n= 71) apresentou redução na média dos níveis de colesterol total (p= 0,316 | IC 95% -24,9-8,1), LDL (p= 0,024 | IC 95% -29,3-2,1) e triglicerídeos (p= 0,969 | IC 95% -28,6-27,5), e aumento do HDL (p= 0,001 | IC95%4,2-10,2).

Conclusão: O uso de 3g de canela por dia, durante 90 dias, parece auxiliar na diminuição dos valores de LDL e aumento dos níveis de HDL em pacientes com diabetes.

Descritores: Cinnamomum zeylanicum. Diabetes Mellitus tipo 2. Lipídeos. Ensaio clínico.

RESUMEN

Objetivo: Evaluar la efectividad de la canela en la reducción de los niveles de lípidos en personas con diabetes.

Método: Ensayo clínico aleatorizado, triple ciego, de grupos paralelos, realizado en Unidades Básicas de Salud de Piauí en 2019. Personas con Diabetes Mellitus tipo 2, entre 18 y 80 años, usuarias de antidiabéticos orales, fueron divididas en dos grupos. El grupo experimental probó 3g de canela durante 90 días.

Resultados: 140 personas participaron en el estudio. De estos, el grupo experimental (n= 71) mostró una reducción en los niveles medios de colesterol total (p= 0,316 | IC 95% -24,9-8,1), LDL (p= 0,024 | IC 95% -29,3 – 2,1) y triglicéridos (p= 0,969 | IC 95% -28,6-27,5) y HDL elevado (p= 0,001 | IC 95%4,2-10,2).

Conclusión: El uso de 3g de canela al día durante 90 días parece ayudar a reducir los valores de LDL y aumentar los niveles de HDL en pacientes con diabetes.

Descriptores: Cinnamomum zeylanicum. Diabetes Mellitus tipo 2. Lípidos. Ensayo clínico.

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INTRODUCTION

Chronic non-communicable conditions have been configured as a complex set of illnesses that are difficult to manage, as they require important behavioral changes, not always adhered by those affected[1]. Given numerous barriers, nurses need to be aware to use skills and competencies that alleviate conditions of lack of control or poor management of these pathologies.

An example of this is the patient with diabetes. Regarded as one of the main disabling conditions worldwide, with more than half a billion people with the disease, representing 10.5% of the global adult population[2], diabetes, when not managed correctly, can lead to renal failure, cardiovascular disease, neuropathy, and causes worsening in patients with ongoing infections, such as respiratory syndromes[3–5]. Moreover, other conditions, such as dyslipidemia, end up establishing in people with a sedentary lifestyle, overweight and risky behaviors – such as many of those with metabolic dysregulation[3].

Once diagnosed in a patient with diabetes, dyslipidemia acts messing up the modulation of vascular and tissue function of the microvasculature in different organs, leading to cardiometabolic disease, bringing early disabilities and multimorbidities to people who have this condition[6]. Other factors such as the accumulation of central adiposity and insulin resistance – typical of people with diabetes, also increase the risk of cardiovascular complications, as they increase the inflammatory response, contributing to the pathogenesis of other chronic conditions, such as atherosclerosis[7,8].

To solve these problems, healthcare professionals need to adapt to respond in time to the health context demands. In this sense, as part of the global strategy of human resources for health until 2030, the Pan American Health Organization/World Health Organization (PAHO/WHO) has encouraged member countries to optimize the actions aimed at vulnerable populations and complex through evidence-based innovations and practices. And, to respond to this imperative, it also promoted the development and improvement of the Advanced Practice Nurse (APN)[9].

The APN can be understood as an expert who has the technical capacity and autonomy to take on activities that involve clinical skills of an expanded scope in the execution of health promotion actions, disease and injury prevention, treatment, and rehabilitation, based on the care practice – core of the profession, in an attempt to respond to the growing health needs of individuals and their families. Furthermore, the literature is unanimous regarding the positive impact of these experts on customer satisfaction, decreased waiting time, reduced costs for governments, better management of chronic conditions, increased access to services and resolution of health problems in different care settings[10].

In the list of strategies aimed at managing patients with chronic conditions, the expert in advanced practices can resort to several devices, technologies and tools that lead to the best care practices. As an example, the use of Integrative and Complementary Practices stands out, and more specifically, phytotherapy. This therapy, regulated in Brazil, can be implemented in different scenarios where the APN acts, such as Primary Health Care, has infinite properties, such as anti-inflammatory, antioxidant, lipid-regulating and anti-diabetic properties[11,12], presenting as a potential resource in the clinic and in scenarios with healthcare demands.

Among the herbal medicines that stand out and have been gaining momentum as adjuncts in the treatment of patients with metabolic dysregulation are cinnamon. A recent meta-analysis showed that cinnamon has a significant influence on the regulation of glycolipid metabolism, and can be safely used as an adjuvant in patients with diabetes[13]. However, studies considering the effectiveness of cinnamon as a lipid-lowering agent in patients with diabetes, especially in the Brazilian population, are still scarce, highlighting the need for further research on the subject. Therefore, the objective of this study was to evaluate the effectiveness of cinnamon in reducing lipid levels in people with diabetes.

METHOD

This is a randomized clinical trial of parallel groups, triple blind (participants, investigator, and statistician), controlled by placebo, conducted between August and December 2019, in five Basic Health Units (BHU), in a city in the state of Piauí. This study was developed in compliance with the recommendations of the Consolidated Standards of Reporting Trials (CONSORT).

The study population consisted of adults and elderly individuals, of both genders, diagnosed with DM2. The inclusion criteria were: having a diagnosis of DM2; being between 18 and 80 years old; and, and using oral antidiabetics. Exclusion criteria were: people using insulin; who reported allergy to cinnamon; who were using another herbal medicine or adjuvant therapy to reduce glycemic, lipid or weight levels; and those with cardiovascular, hepatic, kidney complications or pregnant women.

This experiment had a sample of 140 people, 71 in the experimental group and 69 in the control group. To establish the statistical power of this sample and detect statistical differences, a post hoc analysis was performed using the equation: $\text{Power} = \Phi\{-Z_{1-\alpha/2} + \Delta/\sqrt{\sigma^2_1/n_1 + \sigma^2_2/n_2}\}$, where n1

= sample size of the experimental group; n2 = sample size of the control group; Δ = |μ2-μ1| = absolute difference of mean triglycerides; σ1, σ2 = variance of mean triglycerides of the groups; α = probability of type I error (0.05); β = probability of type II error (0.2); z = critical value Z-value corresponding to α value; Φ {} = function that converts a critical Z-value to power. Based on this calculation, it was found that with this sample size (n=140), the statistical power of the analyses to detect differences between the groups was 95.4%[14].

Before the patients were recruited, all 16 BHU in the urban area of the city were listed and a drawing was made to select the units. From the total, five BHU were previously selected. The number of BHU was achieved based on the number of patients with Type 2 Diabetes Mellitus (DM2) monitored in each of them. Each BHU had, on average, 50 patients diagnosed with DM2, and provided with a minimum structure for carrying out the study – with rooms reserved for collection of biological material, for screening patients and a nursing office, and having service in the morning and afternoon shifts. After the drawing, the BHU were visited, according to the drawing order, and the need to reach the calculated minimum sample (Ex.: the first in the drawing was BHU "A"; if they were included in the study only 30 participants, BHU "B" – the second to come out in the draw, was considered, and so on, until obtaining the sample). Meetings were scheduled with nurses and community health agents from each of the selected BHU, so that the objectives and methods of the study could be presented. Also, to conduct the study, authorization was granted from the technicians responsible/coordinators of the BHU and the Municipal Health Department of the city.

A team of collectors, undergoing training in the healthcare area, trained by the main researcher, was responsible for screening potential participants. Recruitment of potential participants was done through invitation letters, delivered by community health agents in the micro areas where they worked. The letters included orientation about the study and recommendations, such as fasting for possible collection of blood sample collection and the requirement to attend with light clothing for anthropometric measurements, on scheduled dates and times. Approximately 250 patients were recruited, one month before the start of the study. However, only 198 patients attended the BHU, showing interest in participating in the research. Upon arriving at the BHU on the days and times previously scheduled, the main researcher of the study, together with the Family Health Strategy team of each unit, promoted a meeting for clarification on the research, and reading of the Informed Consent Form (ICF), in a reserved room.

Then, the patients were screened, according to the eligibility criteria, in a reserved room for this purpose. From those who attended, 22 could not be included since they did not meet the established criteria, and another 16 refused to participate, after explaining the research team about the study. Finally, 160 people agreed to participate in the research. The ICF was signed with the main researcher, and the participant kept one copy of the document.

Subsequently, data collection began. Each participant answered a socioeconomic and clinical questionnaire, with information about age, gender, skin color, years of education, current occupation, family income, marital status, alcohol and/or tobacco use, medications in use, time since diabetes diagnosis and/or other chronic conditions.

After this stage, participants were directed to the laboratory test collection room. At the time, HbA1c, fasting venous glucose, total cholesterol (TC), triglycerides (TG), HDL-cholesterol, LDL-cholesterol and insulin were collected. However, for this study, it was decided to use only the lipid data analysis. Lipid levels were considered normal or high according to the recommendations of the VI Brazilian Guideline on Dyslipidemias and Atherosclerosis Prevention (2017). For the TC and TG tests, the method used was the Biosystems automated enzymatic method. For HDL and LDL, Biosystems automated kinetic methods and Friedewald equation were used, respectively.

Blood samples were collected after 10 to 12 hours of fasting. The collection was conducted by professionals from the laboratory contracted for this purpose. Biological material was collected in vacuum tubes with anticoagulant. For some tests, in addition to the anticoagulant, a preservative was added. As an example, there is the glucose measurement, which is performed in the plasma obtained by adding EDTA and sodium fluoride. Ten milliliters of blood were collected from each participant. The venipuncture, manipulation and analysis of the biological samples were performed by trained professionals and the analysis was conducted in a clinical laboratory with the CONTROLLAB quality certification, intermediated by the Brazilian Society of Clinical Pathology/Laboratory Medicine, and the quality certification of the National Quality Control Program. Centrifugation of the samples was performed at room temperature and at 3000 rpm for 10 minutes to separate serum from blood cells.

The storage and transportation of biological materials followed the Resolution of the Collegiate Board of the Brazilian Health Regulatory Agency (RDC/ANVISA) no. 306/2004. The researchers did not include the results of the blood samples during the study in the patients' medical records, as these data are part of the research and not part of regular medical

monitoring, which could influence the follow-up of the intervention. Care was taken to avoid errors during blood collection so that there was no need for a new collection.

In another room, anthropometric data (weight, height, waist, neck, thigh, and abdominal circumferences) were extracted. Also, blood pressure was measured on three occasions during the data collection process. It should be noted that the average length of stay of each participant at the BHU to complete this process was one hour. This stage corresponded to T0 or baseline. After 90 days (T90), another collection was conducted, in the same way, in each of the BHU included in the research, so that the data from the beginning could be compared with those obtained at the end of the research. For this purpose, reserved rooms were used on previously scheduled dates and times.

The intervention started one week after the collection of laboratory data. The participants were instructed to return to the BHU to receive the test results, and afterwards they were instructed about the study experiment. Both in the experimental group (EG) and in the control group (CG), people should take four capsules a day, with water, divided into two intakes, 30 minutes before breakfast and lunch. For the EG, the capsules contained cinnamon (Cinnamomum verum), with 750mg, each capsule. The EG intervention dose was based on other research[15]. In the CG, capsules containing placebo (crystalline microcellulose) were delivered, also containing 750mg of the product in each one. All participants were instructed to take the capsules for 90 days.

To produce encapsulated cinnamon, powder was extracted from cinnamon bark by first diluting it with distilled water using a Soxlet extractor to obtain a 0.1% extract. Then, the extract was lyophilized to obtain a powder. Lyophilization did not change the physical-chemical structure of the raw material, allowing its conservation and high microbiological stability, in addition to maintaining the nutritional characteristics of the product. Physical-chemical and microbiological tests were performed by the laboratory manufacturer. After purchasing cinnamon powder, weighing, packaging and quality control tests were conducted by a pharmacy contracted for this service.

It is noteworthy that the capsules, bottles, and labels with information on dosage, expiration date and return date for offering a new bottle were identical in both groups. All bottles were sealed and contained a small packet of silica for conservation. Every 25 or 30 days, a new bottle was delivered to the BHU for the participants. Those absent received reminders via phone call. However, after three unsuccessful attempts, on different days and times, the participants were discontinued from the research.

All participants were encouraged to continue with the medications prescribed by the BHU physicians, as well as to follow eating habits and exercise regularly. They were also informed about the risks and benefits of the study and were aware that they could abandon the study at any time and for any reason, without prejudice to the routine treatment provided by the BHU. Moreover, a form for recording adverse events was made available at each BHU for any complaints. Information about the study was also extended to family members and/or caregivers who accompanied the participants in data collection or during the delivery of bottles containing the products. Thirty days after the end of the intervention, the researcher returned to the places where the study was conducted, to provide information about the outcomes and check for any adverse event.

The randomization of participants in the intervention and control groups was performed by a member of the research group, external to data collection and/or data analysis, with the inclusion of numbers in the Research Randomizer software. These numbers were recorded on bottles with the products offered by the pharmacist responsible for making them. The allocation ratio was 1:1, in parallel groups, with no change in study design or method after the beginning of the research. The group in which each person was assigned was only revealed to the main investigator after data analysis. Thus, the main investigator, participants, and the person responsible for data analysis were all blinded throughout the process.

The analyses of this study were performed by intention to treat. Variables were analyzed descriptively, with numerical and visual summaries. The two groups were compared for differences in socioeconomic and clinical variables at baseline.

The normality of the variables was analyzed using the Kolmogorov-Sminorv test. Next, the outcomes under study (total cholesterol, HDL, LDL, and triglycerides) were compared intra-group, through the paired T-test, and dependent groups. In cases of statistically significant difference, an analysis of the magnitude of this difference was performed using the Cohen Test (Cohen's d) in each of the groups. The interpretation of the effect size in this case was as follows: small (0.2 to 0.5); intermediate (>0.5 to 0.8) and large (>0.8)[16]. To observe the percentage (%) of change in the classification of the participants' biomarkers throughout the research, contingency tables were created. In this case, the chi-square test was used for categorical variables with more than two categories. Fisher's exact test was used to test whether there were differences between groups (frequency <5), and in the distributions of category changes in the assessment of lipid levels. In all analyses, a 95% confidence interval was used;

significance level of 0.05 and the distribution of residuals was observed. However, the analysis was also performed with complete data. Data were interpreted with caution, since the study was not designed to have statistical power for all these tests, which are considered exploratory. Analyses were performed using SPSS version 25 (SPSS Inc., Chicago, IL, USA) and Stata SE 15.0 (Stata Corporation, College Station, TX, USA) software. Graphics were made in RStudio.

The research was approved by the Human Research Ethics Committee, under no.: 3,447,415, and registered in the Brazilian Registry of Clinical Trials under the identification: RBR-2KKB6D.

During the study, a total of 20 participants were lost to follow-up, resulting in a sample of 140 individuals for the final analysis (71 in the cinnamon group and 69 in the placebo group). Figure 1 shows a CONSORT flow diagram for the study. In the EG, three people withdrew from the study due to surgical procedures during follow-up, four withdrew without informing a specific reason, and two traveled during the intervention period and did not return to pick up the bottles. In the placebo group, from the 11 losses, ten were due to withdrawal without a specific reason and one person died from cardiorespiratory complications (not related to the ingestion of the placebo capsule). Individuals lost to follow-up did not differ from those who completed the study in any of their demographic characteristics (data not presented but available by authors upon request).

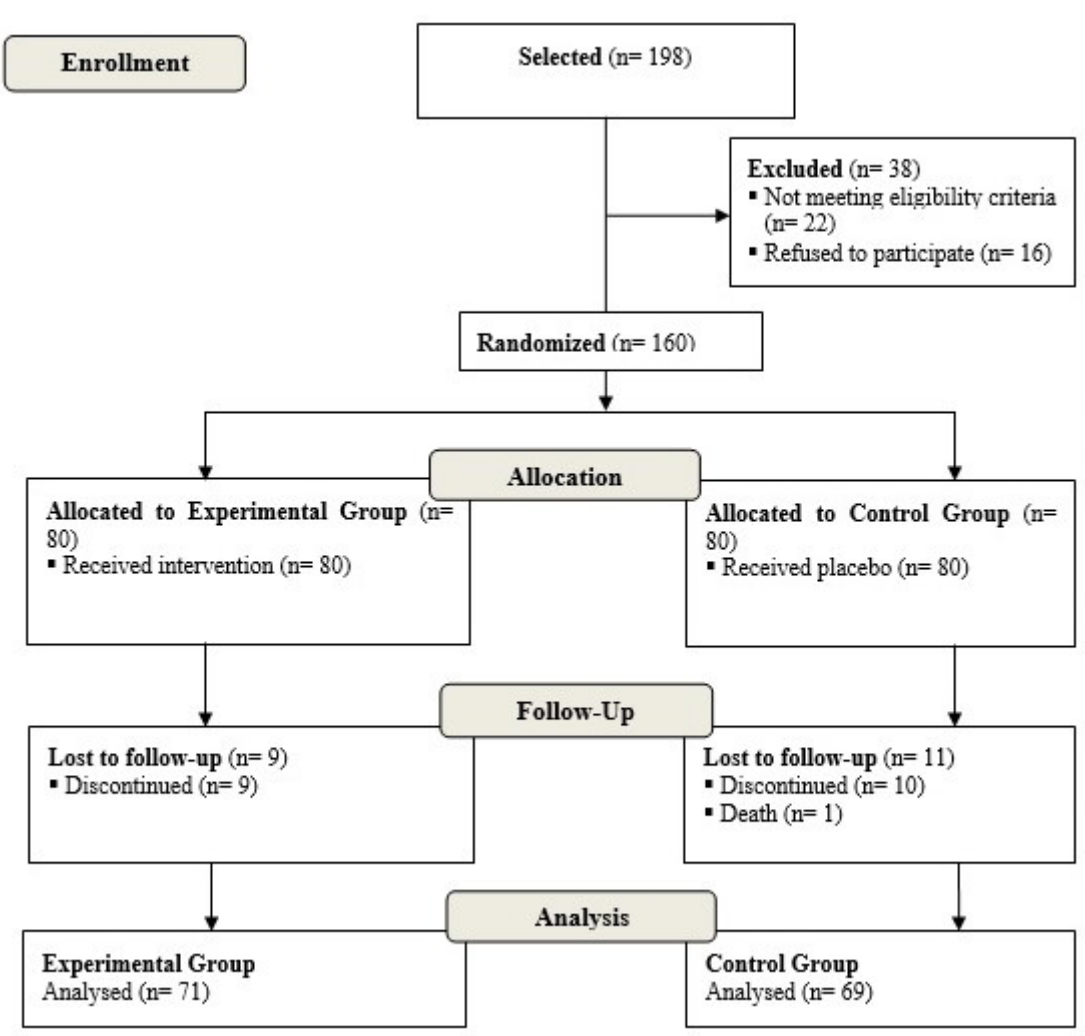

Figure 1 – Clinical trial flowchart. Parnaíba, Piauí, Brazil, 2023
Source: Research data, 2023.

RESULTS

From the 140 participants who were monitored for 90 days, 71 were part of the EG, and 69 were part of the CG. The mean age of participants was 61 years (SD = 11.7). A large part of the sample was female (69.2%), brown-skinned (57.1%), had up to nine years of schooling (52.1%), was married (75%), and lived with a monthly family income of 1,954.50 BRL. Half of the participants were retired. The practice of physical exercise was reported by 29.6% of people in the EG, and 34.8% of those in the CG. Alcohol use was reported by 12.7% of the people in the EG, and 11.6% in those in the CG. In turn, only 5.6% and 8.7% reported tobacco use in the EG and CG, respectively.

Participants allocated to the EG started the study with an average HbA1c of 8.5% versus 8.0% of the CG participants. After the intervention time, those who used cinnamon had a decrease of 0.2% (p = 0.001), and the participants who used placebo, an increase of 0.38% (p = 0.001). In T0, fasting blood glucose had values of 186 mg/dL in EG, and 176 mg/dL in T90. In turn, the CG participants started their participation in the research with an average fasting blood glucose of 162 mg/dL and ended with 183 mg/dL (p = 0.001).

In the participants of the EG, there was an increase in HDL levels (p<0.001), and a reduction in LDL values (p=0.024). In the latter case, the effect size of this difference was small, while for HDL, the effect size could be considered intermediate. In turn, in the CG, an increase in HDL and TG values (p<0.001) was detected in the post-intervention period, but the magnitude of these findings was small in both (Table 1).

In all measurements, most participants did not vary from the initial category, with positive and negative changes in both groups. Therefore, there was no evidence that intervention with cinnamon or placebo administration was better. The only exception was a higher percentage of individuals with elevated TG in the CG, when compared to the EG in the post-intervention (Table 2).

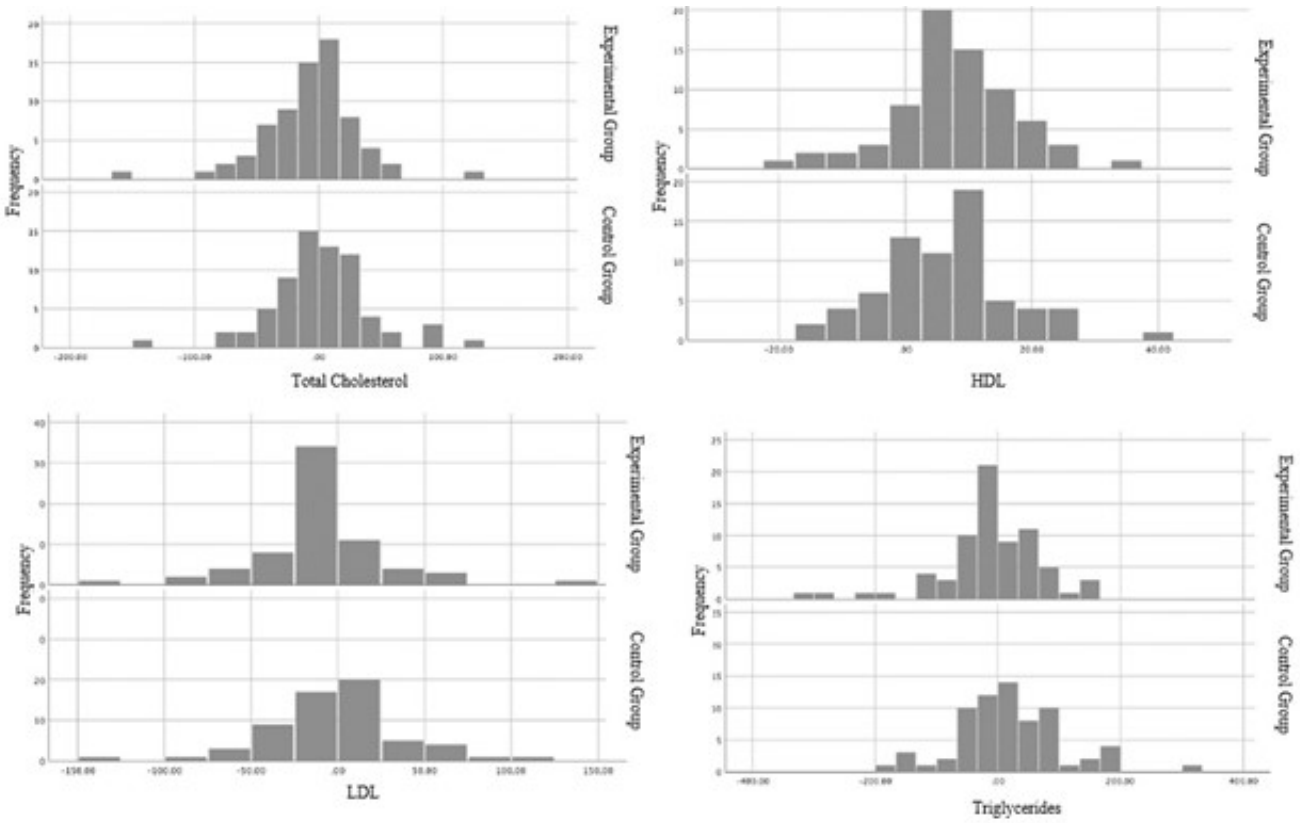

Figure 2 – Differences in total cholesterol, triglyceride, LDL and HDL measurements by allocation group (n= 140). Parnaíba, Piauí, Brazil, 2023
Source: Research data, 2023.

Table 1 – Difference between lipid levels of participants with Type 2 Diabetes Mellitus who completed the 90-day follow-up, by intervention group (n= 140). Parnaíba, Piauí, Brazil, 2023

Biomarker	Experimental Group (n= 71)						Control Group (n= 69)					
	Start $\bar{x}$ (±SD)	End $\bar{x}$ (±SD)	*p*[1]	MD	CI95%	Conhen's d[2]	Start $\bar{x}$ (±SD)	End $\bar{x}$ (±SD)	*p*[1]	MD	CI95%	Conhen's d[2]
TC (mg/dL)	205.3±44.8	196.9±42.5	0.316	-8.3	-24.9-8.1	-0.11	207.2±41.1	213.7±49	0.325	6.4	-6.5-19.5	0.11
HDL (mg/dL)	52.7±11.5	60±9.6	**<0.001**	7.23	4.2-10.2	0.56	51.9±9.1	57.8±10.4	**<0.001**	5.9	2.9-8.9	0.47
LDL (mg/dL)	120.6±37.8	104.8±39.5	**0.024**	-15.7	-29.3-2.1	-0.27	116.5±32.3	119.2±41.3	0.631	2.6	-8.4-13.8	0.06
TG (mg/dL)	186.4±96.5	185.9±83	0.969	-0.54	-28.6-27.5	-0.01	201.1±101	251.4±125.1	**0.007**	50.2	14.5-86	0.33

Source: Research data, 2023.
Legend: [1]p- value calculated by paired t-test; [2]Effect size calculated using Cohen's d. $\bar{x}$=mean; SD=standard deviation; MD= mean difference; CI 95%= 95% confidence interval (minimum-maximum).

Table 2 – Categorization of lipid variables of participants with Type 2 Diabetes Mellitus, followed for 90 days, at the beginning and end of the study, according to the allocation group (n= 140). Parnaíba, Piauí, Brazil, 2023

Variables	EG (n= 71)	CG (n= 69)	p-value*
High TC (≥190 mg/dL),% yes (n)			
Initial	60.6 (43)	72.5 (50)	0.16
Final	56.3 (40)	66.7 (46)	0.23
Change of category			
No change**	70.4 (50)	76.8 (53)	0.67
Normal, High	12.7 (9)	8.7 (6)	
High, Normal (desired)	16.9 (12)	14.5 (10)	
Low HDL (≤ 40mg/dL), % yes(n)			
Initial	15.5 (11)	11.6 (8)	0.62
Final	1 (1,4)	5.8 (4)	0.20
Change of category			
No change**	85.9 (61)	91.3 (63)	0.28
Normal, Low	0.0 (0)	1.4 (1)	
Low, Normal (desired)	14.1 (10)	7.2 (5)	
High LDL*** (≥100 mg/dL), % yes (n)			
Initial	70.4 (50)	65.2 (45)	0.59
Final	52.1 (37)	60.9 (42)	0.31
Change of category			
No change**	70.4 (50)	78.3 (54)	0.23
Normal, High	5.6 (4)	8.7 (6)	
High, Normal (desired)	23.9 (17)	13.0 (9)	
High TG (≥150 mg/dL), % sim (n)			
Initial	59.2 (42)	69.6 (48)	0.22
Final	64.8 (46)	84.1 (58)	0.01
Change of category			
No change**	77.5 (55)	79.7 (55)	0.41
Normal, High	14.1 (10)	17.4 (12)	
High, Normal (desired)	8.5 (6)	2.9 (2)	

Source: Research data, 2023.
Legenda: *chi-square test p-value (exact) for initial and final proportions, and Fisher's exact test for comparison of change of category (done in R Studio) **Normal at both periods or high (low) at both periods ***missing values of three participants in the EG and seven participants in the CG.

In all measurements, most individuals showed no change after the intervention with cinnamon. That is, there were changes for better and worse in both groups. Thus, it was not possible to identify evidence that cinnamon was effective in reducing lipid levels. Except regarding the value of LDL and HDL in the EG. The following histograms plot dispersions of the differences in measurements shown in Table 1, where a wide variation of observed values is evident, without major changes in lipid levels in the EG and CG (Figure 2).

DISCUSSION

In Brazil, a country with a high number of mixed-race individuals, there was no evidence of other studies that conducted interventions like this one, this being the first study that evaluated the effectiveness of cinnamon (*Cinnamomum verum*) as an adjutant in the lipid levels of people with DM2, in the national territory. The outcomes presented show that, after 90 days, there was a decrease in LDL (p= 0.024), TC (p= 0.316) and TG (p= 0.969) values in the participants allocated to the EG. In the same group, HDL levels increased after the intervention (p<0.001). These results are similar to others who explored the use of cinnamon in different concentrations (1-6g/day), showing a reduction in lipid and glycemic levels[17].

In Asians, even when used for a shorter duration than in this study, cinnamon was able to mitigate TG values and TG/HDL ratio in people with DM2[18]. The decrease in lipid levels prevents the progression of negative events linked to adiposity and the development of metabolic syndrome in diabetic patients[19]. This may contribute to further investigations exploring the protective effect of cinnamon in relation to episodes of hypertriglyceridemia, strokes, and other cardiovascular events in patients at a high risk for these changes.

Although it performs essential functions for the human organism, such as the synthesis of hormones and vitamins, and composes the tissue structure in several organs, cholesterols can also lead to an atherogenic condition, in particular, due to an increase in LDL concentrations and a reduction in HDL, favoring the development of coronary artery disease for example[15,19]. Therefore, it is essential to find strategies that mitigate these effects.

In this research, LDL levels decreased from 120.6 to 104.8 mg/dL (p= 0.024) in the EG, leading almost 20% of participants in this group to change category. In the first study published on the topic, the decrease in LDL levels was even greater, reaching 30.93 mg/dL[17]. Favorable results were also found in the Middle East, a region with a high consumption of the spice[20]. Further east in the Asian continent, specifically in India, researchers showed that the continuous and prolonged use of cinnamon decreased not only LDL values, but also TG and TC[21]. Because it is rich in polyphenols and nuclear hormone receptors in its composition, cinnamon has anti-inflammatory, antioxidant, and anti-platelet aggregation activity, improving blood perfusion and blood pressure control. Such properties minimize risks related to the cardiometabolic condition, and reduce plasma levels of TG and LDL, increasing insulin sensitivity and acting on HDL levels in the body[22,23]. Being aware of this helps nurses to act optimally in the planning of strategies and in the management of diabetes.

In this clinical trial, it was observed that TC values decreased in the EG (p= 0.316) and increased in the CG (p= 0.325). This was similar to what Chinese researchers found when they used only 500mg of the products liquid extract[24]. In patients with non-alcoholic liver disease, dietary supplementation with cinnamon also seems to have been effective in reducing TC values, showing a decrease three times greater than that found in the present study. This shows the adjuvant potential of the product in patients with chronic conditions[22].

The HDL cholesterol range was also analyzed, and an increase of 7.3mg/dL (p<0.001) in the mean values of this marker in the EG could be detected. In the CG, gains were also found in relation to HDL (p<0.001). Maybe, this is due to the observation and follow-up process required by the research, inducing participants to have better habits. However, the literature is not coincident, and Chinese researchers have reported a reduction in HDL levels after the supplemental use of cinnamon[24]. The identification and monitoring of HDL levels should be a continuous care of nurses who treat people with DM2, since this biomarker has anti-obesity and insulin-sensitizing effects, has anti-inflammatory and antithrombotic mediators, and decreases the risk of developing dyslipidemia[18].

The benefits of cinnamon were explored by a meta-analysis on the theme, showing that the product has a favorable impact on metabolic abnormalities. Its main active ingredient, cinnamaldehyde, increases hepatic glycogen synthesis, inhibits gluconeogenesis, increases the expression of receptor proteins involved in glucose transport, insulin signaling and dyslipidemia regulation. That is, the use of this phytotherapy is useful in complementing the therapeutic schemes for patients with diabetes[13].

Although notably effective for people with chronic conditions[15,17,20], there is little evidence and discussions that widely describe the results of interventions with cinnamon in reducing lipid values in groups with diabetes. This brings the need for further clarification on the theme, especially in

the context of Primary Health Care, where nurses still have limited tools in their assistance. Therefore, exploring the potential of integrative and complementary practices like this one, easily accessed in different parts of the world, will provide greater dynamism and speed in the care processes for patients with diabetes and risk of dyslipidemia.

Besides cinnamon, other plant derivatives also have similar lipid-lowering effects, such as garlic (*Allium sativum L.*), flaxseed (*Linun usitatissimun L.*), oats (*Avena sativa*), black cumin (*Nigella sativa*), ginger (*Zingiber officinale*) and yellow passion fruit flour (*Passiflora Edulis F. Flavicarpa Deg.*)[12,25–27]. Garlic, for example, commonly used in popular everyday life, has lipid-lowering potential by reducing the serum concentration of TC, controlling TG levels, and oxidizing low-density lipoproteins. Flaxseed, in patients with dyslipidemia, has a reducing effect on TC, LDL and TG levels, and an increase in HDL levels in the short, medium, and long term. Additionally, oats and ginger have been tested and have emerged as effective in the treatment of hyperlipidemia in people with diabetes[12,25].

Due to the chronicity and substantial relationship between DM2 and lipid metabolism dysfunctions, studies like as this one point out to expanding care and establishing low-cost, easily accessible holistic and adjunct therapies that address the social determinants of each patient[26]. Therefore, phytotherapy emerges as a prophylactic measure or resource in the treatment of dyslipidemia in people with diabetes, supported by the use of medicinal plants and plant-based products under the prescription of a qualified professional[24,28].

Amidst of this scenario, the APN can make use of this intervention in its practice, given the high applicability, effectiveness and acceptance of cinnamon in different cultures, reinforcing health-promoting and preventive, autonomous and grounded actions of the professional in the Unified Health System (*Sistema Único de Saúde*) and, especially in Primary Health Care[28,29].

The limitations found in the study come from the lack of data that could be used for a multivariate analysis, not being possible to control the influence of some predictors such as sedentary lifestyle, use of lipid-lowering medications and dietary habits, through specific tests, which may compromise the external validity of the study. Also, the scarcity of further evidence on the subject prevented in-depth expositions and discussions. Finally, the dose and time of the intervention may have limited the availability of more robust results for the investigated outcomes, even if they are based on analyzes previously performed in other regions, where the investigation periods do not exceed 16 weeks.

CONCLUSION

This study showed that the daily supplementation of 3g of cinnamon for 90 days seems to have helped in reducing LDL values and favored the increase of HDL levels in people with DM2. It is highlighted the need to conduct new clinical studies with similar objectives in the country, by adjusting the limitations included here to reformulate the observation under a more accurate view. Furthermore, this is a pioneering research in Brazil, and one of the few directed to the public with diabetes worldwide, which, in addition to testing the product, emphasizes the role of nurses and the innovative nature of nursing care.

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