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Food and nutritional education in reducing cardiovascular risks in individuals with type 2 diabetes

Educação alimentar e nutricional na redução do risco cardiovascular em indivíduos com diabetes tipo 2

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ABSTRACT
The objective of this study was to evaluate the effect of food and nutritional education on eating habits and cardiovascular risk in individuals with type 2 diabetes. In this longitudinal intervention study, participants with type 2 diabetes mellitus were evaluated before and after the intervention with food and nutritional education actions, which were performed every fifteen days for five months. Individuals were evaluated for anthropometry, systemic arterial pressure, food intake, and serum concentrations of fasting glucose and lipid control markers. The Castelli risk indexes I e II were calculated by the total cholesterol/HDL-c ratio and by the LDL-c/HDL-c ratio, respectively. Non-parametric Wilcoxon test for comparison of results between times was performed, with p-value < 0.05 considered significantly different and p-values between 0.05 and 0.10 as marginally significant. The intervention was able to promote improvement in markers related to cardiovascular risk, reducing significantly waist (p=0.015) and hip circumference (p=0.021), triciptal cutaneous (p=0.011) and subscapular cutaneous folds (p=0.005), dietary lipids (p=0.071), total cholesterol (p=0.003), LDL-c (p=0.004) and Castelli I (p=0.033) and II (p=0.002) indexes. Food and nutritional education actions were able to improve markers associated with cardiovascular risks since they the leading causes of morbidity and mortality in individuals with diabetes.

Keywords: Food and Nutrition Education, Diabetes mellitus type 2, Anthropometry, Cardiovascular diseases.

RESUMO
O objetivo deste estudo foi avaliar o efeito da educação alimentar e nutricional nos hábitos alimentares e risco cardiovascular em indivíduos com diabetes tipo 2. Neste estudo longitudinal de intervenção, participantes com diabetes mellitus tipo 2 foram avaliados antes e depois da intervenção com ações de educação alimentar e nutricional, as quais foram realizadas a cada quinze dias durante cinco meses. Os indivíduos foram avaliados quanto à antropometria, pressão arterial, ingestão dietética e concentrações séricas de glicose em jejum e marcadores do controle lipídico. Os índices de Castelli I e II foram calculados a partir da razão colesterol total/HDL-c e da razão LDL-c/HDL-c, respectivamente. O teste não-paramétrico de Wilcoxon para comparação de resultados entre os tempos foi realizado, com p-valor < 0.05 considerado significativamente diferente, e p-valor entre 0.05 e 0.10 como marginalmente significativo. A intervenção promoveu melhora nos marcadores relacionados ao risco cardiovascular, reduzindo significativamente as circunferências da cintura (p=0.015) e quadril (p=0.021), dobras cutâneas triciptal (p=0.011) e subescapular (p=0.005), lipídios dietéticos (p=0.071), colesterol total (p=0.003), LDL-c (p=0.004) e Índices de Castelli I (p=0.033) e II (p=0.002). As ações de Educação Alimentar e Nutricional foram capazes de alterar positivamente

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os marcadores associados aos riscos cardiovasculares, uma vez que estes marcadores estão entre as principais causas de morbidade e mortalidade em indivíduos com diabetes.

Palavras-chave: Educação Alimentar e Nutricional, Diabetes Mellitus Tipo 2, Antropometria, Doenças Cardiovasculares.

1 INTRODUCTION

Type 2 diabetes mellitus (T2DM) is commonly associated with cardiometabolic risk. It has been shown that the usual associated abnormalities (central fat deposition, insulin resistance, systemic arterial hypertension and dyslipidemias) increase the cases of death related to cardiovascular damage.[1]

The risk for cardiovascular disease in individuals with diabetes mellitus is higher than in those who do not have the condition. In 1979, the Framingham study pointed out the risk twice as high as in men and three times in females.[2] The American Diabetes Association declare that individuals with diabetes have an increased incidence of atherosclerosis, cerebrovascular and peripheral arterial diseases.[3]

The increase in diabetes cases is directly associated with reducing the quality of life of these individuals. Alterations in the markers of lipid metabolism and blood pressure are frequent in diabetes and may cause changes in the functions and/or failure of organs, such as the kidneys and heart, as well as nerves and blood vessels.[4]

Food has a central role in the control of complications associated with T2DM and cardiometabolic risk, helping to treat the disease since changes in lifestyle such as healthy eating habits and practice of physical exercises are involved in the treatment of T2DM.[1] In this way, food and nutrition education (FNE) actions are essential to self-care and interaction among individuals with diabetes, and to contribute to the search for new knowledge about the disease, promoting positive results in disease control with consequent improvement in quality of life.[5,6]

Considering the importance of nutritional education for the population with diabetes on knowledge about healthy eating and the health impact of patients with diabetes, the objective of this study was to evaluate the effect of FNE on dietary habits and cardiovascular risks in T2DM.

2 METHODS

2.1 PARTICIPANTS AND PROCEDURES

In this longitudinal study, nine FNE actions were performed, with intervals of 15 days and a total duration of five months, in T2DM individuals (male and female). For inclusion in the study, the following criteria were adopted: age above 19 years and T2DM medical diagnosis. Individuals with medical diagnosis of gestational diabetes mellitus, type 1 diabetes mellitus or pre-diabetes, and those

who were participating in external nutritional monitoring programs were excluded. The sample was selected from a diabetes outpatient clinic.

This research was approved by the Research Ethics Committee (Nº 1.106.436). The written informed consent was obtained from all study participants.

Participants with T2DM were evaluated in two moments: T0 (pre-intervention) and T1 (five months after the beginning of intervention). In both times, participants were evaluated regarding the anthropometric, dietary, and biochemical markers.

The anthropometric evaluation was performed from weight measurements (weight balance, Balmak®), height (stadiometer, Alturexata®), waist and hip circumferences (inelastic and inextensible tape measure, Cescorf®), and Tricipital (TCF) and Subscapular Cutaneous Folds (SCF) (Adipometer, Cescorf®), according to the methods referenced by the Brazilian Food and Nutrition Surveillance System[7] and Petroski[8]. The Body Mass Index (BMI) was obtained dividing weight (kg) by height (m) squared. The Waist-to-Hip ratio (WHR) was obtained dividing waist circumference (cm) by hip circumference (cm). The results of BMI and WHR were classified according to the cut-off points from the World Health Organization (WHO).[9]

Systemic arterial pressure was measured by the auscultatory method with an aneroid sphygmomanometer following the guidelines from the Brazilian Society of Cardiology.[10] Three measurements were made in the right arm, and the measures mean was used.

The participants' dietary intake was evaluated using the 24-hour dietary recall method (R24h), applied in three non-consecutive days, and analyzed with NutWin software (version 1.5).

To evaluate the biochemical markers, participants have fasted for 12 hours, and 15 mL of blood were collected in tubes without anticoagulant to obtain serum. The serum concentrations of glucose, total cholesterol, HDL-c, and triglycerides were determined by commercial enzymatic methods (Labtest®). The LDL-c fraction was calculated using the equation Friedewald, Levy, and Fredrickson.[11] The Castelli I index was calculated by the total cholesterol/HDL-c ratio and the Castelli II Index by the LDL-c/HDL-c ratio.[12]

2.2 FOOD AND NUTRITIONAL EDUCATION ACTIVITIES

From the results obtained at T0, 12 FNE actions were prepared, distributed in nine meetings, with pre-defined methodology, alternating between lectures, workshops, and conversations circles with an average duration of 1 hour and 30 minutes each. The FNE meetings were composed of theory and practice, seeking dynamism in the knowledge fixation. After each FNE, an educational and practical material on the topic discussed was given to the participants, seeking support in the nutritional treatment (*Table 1*).

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Table 1. Description of the activities of Food and Nutrition Education (FNE) carried out for five months in individuals with type 2 diabetes mellitus (T2DM), São Cristóvão, Sergipe, 2015.

FNE ACTIVITIES	*METHODOLOGY*
1st: Knowing the diabetes	Explanatory lecture about diabetes and its types, possible complications and types of treatments, emphasizing the importance of changes in eating and life habits.
2nd: Anonymous Diabetics: My day-to-day with diabetes	Round of conversation among participants, approaching four questions: "What is your name?"; "What is your type of diabetes?"; "How do you deal with diabetes on a day-to-day?" and "What do you expect from FNE?". Participants were able to share experiences, frustrations and expectations about FNE activities.
3rd: How to prepare a dish healthily?	Health dishes preparation workshop was presented using a projector, approaching an explanation about how to prepare healthy dishes respecting the food laws. To stimulate daily consumption of fruits and vegetables, participants received a scoring game, which contained 15 squares, representing the 15 days after FNE. When the participant was able to consume appropriately these foods, they would mark an "X" in the square concerning that day, encouraging individual's self-monitoring.
4th: What is it, what is the use and how to use nutrition labeling as my ally?	The participants were informed about what is food labeling, what it is for and how it is evaluated. After that, food packages of various types were given to the subjects for their evaluation. Then, the participants placed the packages on the Labeling Semaphore, judging them according to the information on the labels. The participants placed in the green part of the semaphore foods they considered "good for consumption", in the yellow part when "consumption should be moderate" and in the red part if the food was "bad for consumption". Finally, the facilitator talked to participants about their choices, emphasizing the priority in consumption of fresh or minimally processed foods.
5th: Myths and truths about diabetes	Participants were placed in a circle and each of them received two plaques: a green (representing truth) and a red (representing myth). Several statements were taken from the "box of myths and truths" and read to the participants. Immediately, they judged as truth or myth, raising the plaques. Participants were encouraged to justify their choices and later the facilitator explained the correct answer to the statement.
6th: "Knowing the Food Pyramid, sugar, salt and fat content in ultra-processed foods and the 10 steps to healthy eating"	Using a projector, the Food Pyramid adapted by Phillip et al.[13] was presented, explaining each food group and its importance. Besides, it was explained the importance of the "10 steps to a healthy diet", proposed by Food Guide for the Brazilian Population.[14] Then, a dynamic was carried out with the aid of a pyramid banner, in which each participant had to paste food images in the pyramid compartments. After that, the facilitator talked to participants about their choices. Finally, a panel previously produced with salt, sugar and fat content from ultra-processed foods most consumed by diabetics (observed from R24h) was exposed, explaining the need for reduction of these foods.
7th: Physical activity and diabetes: what benefits and how do I exercise, using what I have at home?	A physical education professional, with the aid of a projector, explained to the participants the care, benefits and appropriate exercises and relevant information about the practice of regular physical activity in diabetes. Then, the teacher invited them to perform aerobic activities demonstrating in practice how to prepare for walks, exercises and stretches. The nutrition facilitator briefly discussed the relationship between diet and physical activity, specially before and after exercises.
8th: Diet and light foods	With the support of projector, it was explained what they are, their utility and the information that should be sought on the labels of light and diet products.
9th: Use of sweeteners	The facilitator talked about the use of sweeteners, showing each type, their benefits and harms, the daily intake recommendations and the healthier sweeteners options, according to the literature. At the end, packs of sweeteners from different types and compositions were distributed to the participants to judge them according to their composition as "restricted consumption", "moderate consumption" or "consumption priority" for individuals with diabetes.
10th: Carbohydrate Count	The action was divided in two moments. In the first one, a lecture about carbohydrate count was performed. In the second moment, the dynamics of the action occurred through the preparation of dishes, using the carbohydrate count. Each participant had a plate and several printed food images to put into practice the theory previously

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	explained. At the end of the time given for the activity, the facilitator showed how the dishes should be set according to the correct carbohydrate count.
11th: Food in times of crisis: how to make healthy shopping spending little?	In a dynamic conversation, questions such as "Can I eat healthily spending little?" and "Where can I find cheap food?" were answered. Using a projector, the "10 tips to eat healthily spending little" were presented, making price comparisons between supermarkets and free markets.
12th: World Coffee - Coffee with Prose: a different review!	This dynamic consisted of participants expressing in paper posters everything they learned in every encounter through words, phrases, drawings, graphics and balloons, in an estimated time of 20 minutes. The purpose of this dynamic was to carry out a general review of what was seen since the first FNE meeting until the last. At the end, the panels produced were discussed in order to review all the topics approached over the five months of intervention.

2.3 DATA ANALYSIS

The results for the participants' characterization were analyzed descriptively and presented in absolute (n) and relative (%) frequency. Anthropometric assessments, food intake, and glycemic and lipid markers were presented in means and standard deviations. Shapiro-Wilk test was performed to verify the data normality, which did not present normal distribution. Thus, a non-parametric Wilcoxon test was applied to compare the means. A p-value < 0.05 was considered statistically significant, while p-values between 0.05 and 0.10 were considered marginally significant.[15] The Statistical Package for the Social Sciences (SPSS), version 19.0, was used for data analysis.

3 RESULTS

Initially, 23 individuals with T2DM were selected to form the FNE group. However, the study was concluded with 12 individuals' participation, and this number was effective in achieving the proposed objectives. The participation in the activities was 75% (each participant attended seven of the nine FNE meetings), and the majority of the participants were men (58.3%). The mean age and time of diagnosis of T2DM were 53.5 and 8.63 years, respectively. Two individuals were on insulin therapy. All subjects evaluated were taking oral antidiabetic agents. As for other drugs, 41.6% of the patients used antihypertensive medication. None of the individuals used oral lipid-lowering agents.

Analyzing the anthropometric profile, there were significant reductions in waist (p=0.01) and hip circumferences (p<0.001), WHR (p=0.02), SCF (p<0.001) and TCF (p=0.01), without significant changes in BMI and blood pressure after FNE (*Table 2*). It was also observed that two individuals classified as obese degree 1 passed to pre-obesity in T1. Besides, the number of eutrophic individuals increased from two (T0) to four in T1.

Table 2. Anthropometric and blood pressure profile of participants with type 2 diabetes mellitus (T2DM) in pre (T0) and post-actions (T1) of Food and Nutrition Education (FNE), São Cristóvão, Sergipe, 2015.

Variables	*T0*	*T1*	*p**
Age (years)	53.50 (8.89)	-	-

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Weight (kg)	75.85 (14.75)	74.97 (15.12)	0.16
BMI† (kg/m²)	28.48 (5.44)	28.24 (5,52)	0.43
WC‡ (cm)	98.59 (12.70)	90.13 (15.24)	**0.01**
HC§ (cm)	102.16 (10.03)	100.09 (9.71)	< **0.001**
WHR‖	0.96 (0.05)	0.90 (0.12)	**0.02**
SCF¶ (mm)	22.42 (9.71)	19.08 (5.58)	< **0.001**
TCF** (mm)	15.75 (6.30)	13.42 (4.93)	**0.01**
SBP†† (mmHg)	126.41 (15.88)	130.00 (14.14)	0.86
DBP‡‡ (mmHg)	72.50 (20.94)	77.50 (10.35)	0.72

Results presented as mean (standard deviation). *Wilcoxon test (p-value <0.05). n=12.
†Body Mass Index; ‡Waist Circumference; §Hip Circumference; ‖Waist-to-Hip ratio; ¶Subscapular Cutaneous Folds; **Triciptal Cutaneous Folds; ††Systolic Blood Pressure; ‡‡Diastolic Blood Pressure.

The assessment of food intake is presented in *Table 3*. The intervention with FNE significantly reduced the intake of lipids in T2DM individuals (p=0.07).

Table 3. Dietary intake of macro and micronutrients of type 2 diabetes mellitus (T2DM) participants in pre (T0) and post-actions (T1) of Food and Nutrition Education (FNE), São Cristóvão, Sergipe, 2015.

Variables	*T0*	*T1*	*p**
Energy (kcal/day)	1648.36 (508.19)	1580.45 (796.44)	0.69
Carbohydrate (g/day)	201.22 (90.08)	161.80 (63.05)	0.15
Protein (g/day)	83.13 (40.03)	33.59 (24.85)	0.20
Lipids (g/day)	61.19 (31.06)	46.51 (29.92)	**0.07**
Saturated fatty acids (%)	7.58 (3.78)	7.96 (4.47)	0.87
Monounsaturated fatty acids (%)	8.12 (3.41)	9.13 (4.78)	0.23
Polyunsaturated fatty acids (%)	2.91 (0.96)	3.45 (1.68)	0.18
Zinc (mg/day)	7.80 (3.03)	9.22 (5.35)	0.69
Calcium (mg/day)	570.87 (220.08)	727.95 (402.99)	0.18
Iron (mg/day)	12.42 (6.07)	16.10 (12.70)	0.63
Copper (mg/day)	0.91 (0.50)	2.12 (2.72)	0.30
Sodium (mg/day)	1684.68 (789.98)	1846.83 (31.06)	0.43
Potassium (mg/day)	2582.92 (914.67)	3342.60 (31.06)	0.30

Results presented as mean (standard deviation). *Wilcoxon test (p-value < 0.05: significant; p-values between 0.05 and 0.10: marginally significant). n=12.

When evaluating the effect of FNE (T1) actions on glycemic and lipid control markers, significant reductions in total cholesterol (p<0.001), LDL-c (p<0.001), and Castelli I (p=0.03) and II (p<0.001) indexes were observed (*Table 4*).

Table 4. Metabolic markers of participants with type 2 diabetes mellitus (T2DM) in the pre (T0) and post-actions (T1) of Food and Nutrition Education (FNE), São Cristóvão, Sergipe, 2015.

Variables	*T0*	*T1*	*p**
Fasting glucose (mg/dL)	141.50 (53.62)	119.71 (54.07)	0.32
Triglycerides (mg/dL)	126.58 (26.98)	127.69 (97.82)	0.79
Total cholesterol (mg/dL)	197.06 (33.71)	141.83 (26.60)	**<0.001***
HDL-cholesterol (mg/dL)	39.86 (9.58)	37.34 (6.36)	0.37
LDL-cholesterol (mg/dL)	131.24 (31.79)	78.95 (31.83)	**<0.001***
Castelli I (CT/HDL)	5.09 (0.04)	3.83 (0.99)	**0.03***
Castelli II (HDL/LDL)	3.49 (1.15)	2.06 (0.96)	**<0.001***

Results presented as mean (standard deviation). *Wilcoxon test (p-value <0.05). n=12.

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4 DISCUSSION

The actions of FNE were effective in improving metabolic control. Menezes et al. (2020)[16] observed a reduction in fasting glucose of individuals who participated in an educational action on diabetes. In the current study, the improvement in metabolic control attenuated cardiovascular risks by significantly reducing critical markers associated with the development of cardiometabolic diseases. The International Diabetes Federation proposed that increased waist circumference, triglycerides ≥ 150 mg/dL, systolic blood pressure ≥ 130 mmHg, diastolic ≥ 85 mmHg and fasting glucose ≥ 100 mg/dL, besides of reduction of HDL-c < 40 mg/dL in men and 50 mg/dL in women, are indicators of cardiovascular risk. The presence of three of the five criteria described above is associated with the diagnosis of Metabolic Syndrome and worsening of health, especially in individuals with diabetes.[17,18]

The waist circumference has been used in many studies to assess cardiovascular risk in various populations.[19-21] Results from the International Day for the Evaluation of Abdominal Obesity (IDEA) showed that the 14 cm increase in men's waist and 14.9 cm in women's, rise the probability of developing CVD from 21% to 41%.[22] In this study, the FNE actions were beneficial to promote the waist circumference reduction in T2DM individuals.

The elevated BMI is associated with cardiovascular risk and worsening of diabetes management, as observed in a study performed by Lira et al.[23] However, the anthropometric indicators of central obesity, such as waist circumference, seem to be better associated with cardiovascular risk than anthropometric indicators of total obesity (BMI).[23]

The reduction of skinfolds has a positive impact on the improvement of insulin sensitivity and the reduction of CVD risk. It has been suggested that decreases in body fat excess are associated in both sexes with the reduction of metabolic abnormalities.[24] Such a reduction in the anthropometric measurement was observed in the present study. In general, the improvement in anthropometric variables can improve the individuals' quality of life with diabetes, acting in disease control, circulating lipids and blood pressure levels, and consequently reducing the complications associated.[24]

The influence of dietary fats and fatty acids on the risk factors for CVD and plasma concentrations of lipids has been widely demonstrated in several experimental and population studies.[2,12,19] Erroneous eating patterns significantly affect the chances of atherosclerotic events and cardiovascular risk, especially in individuals with diabetes. The high fat intake is closely related to the elevation of plasma LDL-c and to the increase of cardiovascular risk.[25] The reduction of dietary lipids observed in the post FNE of the present study points to the lower potential of future cardiovascular events.

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Several studies have shown a direct association between the reduction of cholesterol and LDL-C with regression of atherosclerosis and other CVDs.[24,26] Evidence for association of elevated cholesterol as a significant risk factor for the development of these comorbidities are increasing. Cholesterol and LDL-c elevated act on the development of the fat deposit in the endothelial layer, contributing to the formation of atherosclerotic plaques, which causes obstruction of the arteries and increasing the risk for complications related to heart disease.[4] Changes in lifestyle and diet are essential for reducing the risk of cardiovascular outcomes.[10]

Another way to evaluate cardiovascular risk in this population was through the Castelli I and II indexes. The risk for CVD increases when the Castelli I e II indexes are greater than 4.4 and 2.9, respectively.[12] In this study, it was observed that these indexes were reduced after the intervention, which, in association with the other markers, promoted the reduction of cardiovascular risk in this population.

One of the best ways to evaluate the cardiovascular risk is through the cholesterol/HDL-C ratio. In the Framingham Heart Study, 22000 North Americans with low cardiovascular risk were followed up for 35 years. It was observed that the ratio cholesterol/HDL-C greater than 4.4 defined exactly who would develop CVD over the next five years.[12] This fact confirms the assertion of William Castelli regarding the importance of this relationship in the determination of cardiovascular risks.

5 CONCLUSION

The FNE was effective in improving the markers associated with cardiovascular risk (waist and hip circumferences, WHR, TCF, SCF, dietary lipids, total cholesterol, LDL-c, and Castelli I and II indexes), showing the need for more intervention actions with shorter intervals of time. Nutritional strategies for this purpose show the importance of knowledge to change lifestyle habits and the promotion of care for disease control and reduction of comorbidities.

The sample size may be considered a limiting factor in the study, whereas, with a larger sample size, the effectiveness of intervention could be extended to other markers. Besides, long-term education strategies can hinder adherence to these activities.

The results of this research promise to reduce metabolic complications caused by poor disease control since cardiovascular diseases are among the leading causes of morbidity and mortality in individuals with diabetes.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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