Effect of a therapeutic education methodology on type 2 diabetes mellitus patients by the assessment of biochemical, anthropometric, and dietetic changes

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ABSTRACT

Objective: The objective of this study is to demonstrate the effect of the therapeutic education methodology on the metabolic control of type 2 diabetes mellitus patients participating in the Nutritional Intervention Program in Chronic Diseases (PINEC, Spanish acronym) by the evaluation of biochemical, anthropometric, and dietetic parameters.

Methodology: PINEC is a group nutrition attention model based on a therapeutic education approach. This descriptive study included people over 20 years old participating in PINEC from 2012 to 2016. The metabolic control was evaluated at the beginning and the end of the study period.

Results: The educational intervention was completed by 1280 users (85%) of the initial population integrated by 72% of women and with an average age of 53 ± 11 years; the results showed a significant decrease in the hemoglobin A1c level (HbA1c) and an increase in the body mass index (BMI). The dietary intervention was assessed through the evaluation of food intake and dietetic parameters.

RESUMEN

Propósito: Demostrar el efecto de la metodología de educación terapéutica en el control metabólico de las personas con diabetes mellitus (DM) que participaron en el Programa de Intervención Nutricional en Enfermedades Crónicas (PINEC), mediante la evaluación de variables bioquímicas, antropométricas y dietéticas.


Resultados: Completaron la intervención educativa 1280 usuarios (85% de la población inicial), con edad promedio 53 ± 11 años; el 72% eran mujeres. Se logró una disminución significativa en la hemoglobina gluco-...
INTRODUCTION

Diabetes mellitus (DM) is a metabolic disorder that has its origin in multiple factors. It is located within the group of chronic non-communicable diseases, whose prevalence is increasing. These diseases cause 60% of deaths worldwide and about 47% of health expenditures. It is expected that, by 2020, they will be the main cause of death and disability in the underdeveloped countries. Nowadays, > 382 million people in the world have DM and it is estimated that, by the year 2035, there will be 592 million. In 2013, about 5.1 million people between the ages of 20 and 79 died from this disease, which translates into one death every 6 s. In this same year, the estimated health cost of diabetic patients was 548 billion dollars.

DM is associated with the risk of premature death, representing 6.8% of overall mortality from all causes. On the other hand, Type 2 DM specifically...
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Rev ALAD. 2018;8

constitutes between 85 and 95% of all cases of diabetes in the world, and it is estimated that about 10% of people with altered blood glucose levels will develop this disease and its prevalence for the year 2030 will be 4.4%, fifth cause of death worldwide[1]. In Costa Rica, according to the surveillance survey of cardiovascular risk factors for 2014, the prevalence of diabetes was 12.8% (10% DM diagnosed and 2.8% undiagnosed)[3].

The goal of treatment in a patient with diabetes is glycemic control, to prevent or delay the onset of acute or chronic complications, to promote a better quality of life, and to decrease mortality[4,5]. Complications from diabetes are due to poor control of the disease, lack of knowledge about it, little commitment, lack of family support, and motivation to carry out the treatment, among others[6].

One of the main parameters used to measure the control of diabetes is glycosylated hemoglobin (HbA1c), and scientific evidence indicates that, for each 1% reduction in HbA1c, the risk of microvascular and macrovascular complications is reduced by 35-45% in people with diabetes[7-9].

The diabetes control and complications trial, conducted in the United States for 10 years in patients with Type 1 diabetes, and the UKPDS: Prospective Study on Diabetes in the United Kingdom, carried out for > 10 years with patients with Type 2 diabetes, demonstrated that maintaining glycemic control with a 7% HbA1c as a target, on average, reduces the possibility of developing chronic complications, such as retinopathies, nephropathies, and neuropathies by 50%[8,9].

The American Diabetes Association (ADA) establishes that a patient with adequate control is one who has HbA1c < 7%, fasting glycemia between 80 and 130 mg/dL, and postprandial glycemia < 180 mg/dL[10].

To achieve these goals, a process of education and patient accompaniment is required[11]. This process can be obtained through therapeutic education, which according to the World Health Organization[12], therapeutic education is the “set of essential educational activities for the management of chronic diseases, carried out by health professionals trained in the field of education, created to help the patient or groups of patients and relatives to carry out their treatment and prevent avoidable complications, while maintaining or improving the quality of life.”

The objectives of therapeutic education are to provide information and provide practical knowledge to achieve adherence to medical treatment, but above all, modify behaviors and healthy lifestyles, education is an essential component in the treatment of DM and any other chronic disease, and it is not to replace the medical treatments but to provide necessary tools to face the changes that must be made in the lifestyle, to have better health[13,14].

The educational actions in diabetes carried out in this way make possible the appropriation of knowledge, the improvement of the quality of life, the reduction of problems and damages caused by the disease, and the critical reflection of what needs to be done to correct these problems[15-17].

According to scientific evidence, educational intervention programs contribute to faster short-term self-care practices, and the findings have also shown that group sessions in people with DM focused on understanding their illness are more effective than conventional or individual interventions regarding metabolic control and parameters that are maintained in the long term, such is the case of HbA1c[17].

With the purpose of contributing to the control of diabetes in Costa Rica, the participating in the Nutritional Intervention Program in Chronic Diseases
(PINEC) was created and implemented in the health system of the Costa Rican Social Security (CCSS, acronym in Spanish). The PINEC was designed under guidelines for the development of diabetes education programs established by the education committee, DOTA\textsuperscript{18}. PINEC has a group of nutritional care methodology based on a novel, dynamic, systematized, and integrated learning experience for the prevention and control of diabetes\textsuperscript{19}. The program considered therapeutic education based on competencies, a process in which educators are mediators of learning with the ability to build an environment where the user is autonomous in the management of their disease\textsuperscript{20}. The objective of this article is to describe the results in metabolic control, through changes in the biochemical, anthropometric, and dietary indicators of people with DM who participated in the PINEC.

**METHODOLOGY**

**Type and study population**

A descriptive and comparative study of the PINEC result indicators was carried out. The target population was men and women over 20 years of age diagnosed with DM who participated in the educational intervention of the PINEC in 23 health facilities of the CCSS during the period 2012-2016.

**Description of the nutritional intervention PINEC**

The educational process consists of six group sessions of 2 h each distributed in two modules: intensive (three sessions in a row, once a week) and maintenance (three sessions at 2, 4, and 6 months). To unify the thematic contents included in PINEC, an educational guide was elaborated and topics were contemplated on basic aspects of diabetes care, generalities of the illness, nutrition and its relation with the pharmacological treatment, cardiovascular health, control and reduction of weight, benefits of physical activity, and resolution of daily life situations.

The nutrition professional is responsible for the implementation and execution of the PINEC, for which he was trained in these subjects through a course of 45 h, to standardize concepts and provide them with the necessary tools to develop the PINEC.

The attendance modality was defined with active-participative educational activities, forming small groups of between 8 and 10 users and their families. For each session, there is an outline of the topics, activities, and teaching materials to be used.

The PINEC has structure indicators (number of trained nutrition professional, professional hours dedicated to PINEC, facilities, and equipment), process indicators (percentage of people with diabetes or prediabetes incorporated in PINEC, percentage of participants who completed the program, and number of groups by category that completed the PINEC), and result indicators (evaluation of biochemical, anthropometric, and dietetic indicators).

In the initial consultation, the nutrition professionals collected information on demographic variables (sex, age, education, and occupation), personal and family pathological history, time of diagnosis of the disease, prescribed treatment, and the professionals also took the anthropometric measurements (body weight, body mass index [BMI], abdominal circumference, and body fat percentage). In addition, they recorded the usual daily diet to assess the consumption of food which was classified as adequate, deficient, and excessive, according to the pattern of consumption established in PINEC, for
this population (Appendix 1). It was also recorded if there were problems in the realization of meal times.

The biochemical data (fasting glycemia, postprandial glycemia, HbA1c, total cholesterol, high-density lipoproteins, low-density lipoproteins, and triglycerides) were taken from the clinical record.

Biochemical, anthropometric, and dietary variables at the beginning and the sixth session of the educational intervention were analyzed.

### Statistical analysis

All information was collected from the database of each health facility. The statistical analysis was carried out with the statistical program SPSS 16.0. The descriptive characteristics of the study patients are presented in means and standard deviations for the continuous variables and as percentages for the categorical variables; Student's t-test for paired samples was used to present differences in the averages of the glycemic, biochemical, and anthropometric indicators at the beginning
and end of the intervention with a significance level of 5%.

**RESULTS**

This study presents data of 1280 patients with diabetes who completed the educational intervention, corresponding to 85% of the patients who entered the program. The profile of this population is presented in table 1, where 72% were women. The mean age was 53.0 ± 11 years, 55.6 ± 12 years for men and 54.2 ± 11 years for women. 71% of the patients were in the group age of 40-64 years, and in relation to occupation, 42.7% were housewives.

Table 2 shows the pathological background of the participants, both personal and familiar, and the epidemiological profile was similar to the one presented in the country, where hypertension is the most prevalent disease (71.3%). For the control of these pathologies, 71.8% of this population consumed some type of medication. In the family history, hypertension and diabetes were the most prevalent risk factors.

Regarding lifestyle, only 39.3% performed some kind of physical activity daily and 13.1% of the population reported consuming liquor occasionally.

On average, the study population had 9.7 ± 7.9 years of diagnosis of the disease and 54.9% had < 10 years. Half of the population received insulin as treatment (Table 3).

Table 4 shows the results of 702 patients who had available data on the glycemic and lipid indicators at the beginning and end of the educational intervention. Statistically significant differences were observed in the glycemic parameters (fasting glycemia, postprandial glycemia, and HbA1c). In relation

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**Table 1. Sociodemographic characteristics of patients with type 2 diabetes**

<table>
<thead>
<tr>
<th>Variables</th>
<th>n = 1280</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>360 (28.1)</td>
</tr>
<tr>
<td>Females</td>
<td>920 (71.9)</td>
</tr>
<tr>
<td>Age, years mean (SD)</td>
<td>53 ± 11</td>
</tr>
<tr>
<td>Males</td>
<td>55.6 ± 12</td>
</tr>
<tr>
<td>Females</td>
<td>54.2 ± 11</td>
</tr>
<tr>
<td>Age categories (years) (%)</td>
<td></td>
</tr>
<tr>
<td>20-39</td>
<td>10</td>
</tr>
<tr>
<td>40-64</td>
<td>70.8</td>
</tr>
<tr>
<td>≥ 65</td>
<td>19.1</td>
</tr>
<tr>
<td>Education (%)</td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>25.3</td>
</tr>
<tr>
<td>High school</td>
<td>14.2</td>
</tr>
<tr>
<td>Technical</td>
<td>3.8</td>
</tr>
<tr>
<td>University</td>
<td>14.4</td>
</tr>
<tr>
<td>Occupation (%)</td>
<td></td>
</tr>
<tr>
<td>Housewives</td>
<td>42.7</td>
</tr>
<tr>
<td>Retired</td>
<td>14.9</td>
</tr>
<tr>
<td>Employees</td>
<td>42.1</td>
</tr>
<tr>
<td>Unemployed</td>
<td>0.3</td>
</tr>
</tbody>
</table>

**Table 2. Pathological history of patients with type 2 diabetes**

<table>
<thead>
<tr>
<th>Variables</th>
<th>n = 1280</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal (%)</td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>71.3</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>54.5</td>
</tr>
<tr>
<td>Cardiac arrest</td>
<td>4.3</td>
</tr>
<tr>
<td>Cancer</td>
<td>3.4</td>
</tr>
<tr>
<td>Family history (%)</td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>69.5</td>
</tr>
<tr>
<td>Hypertension</td>
<td>55.4</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>29.8</td>
</tr>
<tr>
<td>Cardiac arrest</td>
<td>26.4</td>
</tr>
<tr>
<td>Cancer</td>
<td>33.1</td>
</tr>
<tr>
<td>Obesity</td>
<td>23.4</td>
</tr>
</tbody>
</table>
to lipid values, a significant reduction in triglycerides was found; however, although there were changes in the other parameters, these were not statistically significant.

In relation to anthropometric indicators, at admission, 93.1% of the patients had a BMI ≥ 25, 315 patients were overweight (24.6%), and 877 (68.5%) patients were obese. Among women, the presence of obesity was greater, 51.2% compared to 17.3% in men (p = 0.001). On average, the BMI was > 33 in both men and women, at the beginning and end of the intervention.

The median abdominal circumference at the beginning of the study for men was 108 cm and for women 105 cm, and it was observed that women achieved a greater decrease. Only this parameter showed a statistically significant reduction in both sexes, on average of 1.1 cm (Table 5).

It was observed that, at the beginning of the intervention, 51.7% of the patients had problems to perform one or several meal times during the day, mainly accentuated in the snacks; at the end of the intervention, 16.1% still showed difficulties (Fig. 1).

Regarding the daily food intake, according to the pattern established for this program and using the usual diet registry, it was determined that the consumption of breads, cookies, fats, and sugars decreased and the consumption of legumes, fruits, vegetables, and food sources of protein increased at the end of the educational intervention (Table 6).

**DISCUSSION**

In this descriptive study, data showed that the majority of participants were women, which agrees with other articles where the prevalence is higher.
than in men\textsuperscript{3,5,6,21}. Cubero et al.\textsuperscript{22} determined a significant variation where men present a lower rate, with a ratio of one for every three women. Pimentel\textsuperscript{6} showed a higher prevalence in women and also showed that diabetes is more common in people around 64 years of age. 71\% of the population of this study was in the age group of 40-64 years, with an average age of 55 years, matching with the study data of Mendoza et al.\textsuperscript{23}, where 85\% were in that age range.

Regarding the educational level of the participants, 25.3\% completed primary school and only 14.4\% managed to obtain a university degree, and the evidence indicates that education may be directly related to knowledge of the diseases and adherence to treatment\textsuperscript{24}; Pimentel\textsuperscript{6}, in his study, presented the educational level as a factor that strengthens, weakens, or interferes in the self-care activities of people with DM, and therefore, as a determinant of their health.

In PINEC, participants also reported, besides diabetes, other diseases such as hypertension (high blood pressure [HBP]) and dyslipidemia, which highlights the strong association between DM and HBP\textsuperscript{25}, and in addition, these are strongly related with eating habits and lifestyle\textsuperscript{1}. Patients with diabetes who have other chronic diseases and participate in an educational intervention significantly improve their blood pressure, cholesterol, and triglyceride levels, as well as serum glucose levels and BMI, as shown in several studies\textsuperscript{3,24}.

By the time, the patients entered the program, and they had 9.7 ± 7.9 years of disease diagnosis, during which time the development of secondary complications due to the diabetes was possible, which may be related to with the lack of lifestyle changes, inconsistency in the taking of medication or deficiency of metabolic control\textsuperscript{4,25}.

Achieving good metabolic control of the disease does not only depend on the patient or the medical attention provided, therapeutic education also plays a fundamental role delaying or avoiding

Figure 1. The Nutritional Intervention Program in Chronic Diseases influence on the patients’ eating habits.

<table>
<thead>
<tr>
<th>Meal Time</th>
<th>Initial (%)</th>
<th>Final (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td>8.6</td>
<td>0</td>
</tr>
<tr>
<td>Lunch</td>
<td>13.4</td>
<td>3.0</td>
</tr>
<tr>
<td>Snack</td>
<td>38.9</td>
<td>16.2</td>
</tr>
<tr>
<td>Dinner</td>
<td>17.1</td>
<td>5.4</td>
</tr>
<tr>
<td>Total</td>
<td>51.7</td>
<td>16.1</td>
</tr>
</tbody>
</table>

Table 6. Influence on the patient’s diet according to PINEC’s guidelines and daily food consumption, according to pattern established for PINEC, 2016

<table>
<thead>
<tr>
<th>Food group</th>
<th>Adequate*</th>
<th>Initial %</th>
<th>Final %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starches (excluding beans and lentils)</td>
<td>According to food plan</td>
<td>91.8</td>
<td>58.3</td>
</tr>
<tr>
<td>Beans, lentils and chickpeas</td>
<td>At least 2 portions</td>
<td>36.8</td>
<td>81.1</td>
</tr>
<tr>
<td>Fruits</td>
<td>At least 2 portions</td>
<td>37.8</td>
<td>56.8</td>
</tr>
<tr>
<td>Sweets and desserts</td>
<td>Ideal to avoid</td>
<td>57.0</td>
<td>13.6</td>
</tr>
<tr>
<td>Non-starchy vegetables</td>
<td>At least 2 portions</td>
<td>36.8</td>
<td>78.3</td>
</tr>
<tr>
<td>Protein</td>
<td>At least in 2 meals</td>
<td>24.5</td>
<td>46</td>
</tr>
<tr>
<td>Fat</td>
<td>According to food plan</td>
<td>51.1</td>
<td>30.6</td>
</tr>
</tbody>
</table>

PINEC: Nutritional Intervention Program in Chronic Diseases. *According to appendix 1.
chronic complications. Cubero et al.\textsuperscript{22} mentioned that, due to the same behavior of diabetes, it is relevant to redirect efforts and rethink the intervention strategy, and they also indicate that structured education programs focused on self-care and empowerment to promote the metabolic changes achieved to be sustained or improved in the short term. During the modification of lifestyle, continuous and systematic therapeutic education should be included where the necessary information and skills are provided in order for the patients to make decisions related to their illness and also allow them to take control of their condition\textsuperscript{9,15,24}.

When comparing conventional or individual interventions with group sessions focused on understanding the disease, the latter have shown to be more effective regarding metabolic control in the long term\textsuperscript{17,26}. Trento et al.\textsuperscript{27} demonstrated that group intervention has a greater effect on the acquisition of new knowledge when the process is adapted to the needs and characteristics of the patient, regardless of schooling and age, characteristics contemplated in the PINEC.

A series of studies in this type of educational interventions have observed significant decreases in BMI, waist circumference, fasting blood glucose, postprandial glycemia, total cholesterol, blood pressure, triglycerides, and HbA1c, confirming that the strategies are favorable in the metabolic control of the person with diabetes in the short-term\textsuperscript{24,28-33}.

The results of this study show significant changes in HbA1c, fasting glucose, and postprandial glucose after the educational process. The Hb1Ac had a decrease of 0.95%, which is higher than that reported by Mendoza et al.\textsuperscript{23} who obtained a percentage decrease of 0.69%. On the other hand, the fasting glycemia decreased 12% and postprandial glycemia 11%, which agrees with results from other studies\textsuperscript{23,33}.

The lipid profile showed significant changes only in blood triglycerides; however, none was within the ranges of good control established in the DM guide for Costa Rica\textsuperscript{34}, although > 50% of the population receive medications to control it.

In this study, it was found that 68.5% of the population presented obesity, which corresponds with some studies\textsuperscript{3,4,25}, and the abdominal circumference was the only anthropometric parameter that decreased significantly. These data show the difficulty in decreasing body weight, as shown by the BMI which did not vary throughout the intervention. In the PINEC, the loss of body weight was not part of the therapeutic objectives, since the main objective was the achievement of glycemic control.

In general, there is evidence that lifestyle determines a better health level and, within healthy habits, a balanced diet is essential to the prevention of a large number of diseases\textsuperscript{35}. The ADA established in the nutritional recommendations for adult patients with diabetes that the feeding plan must be individualized, with an adequate distribution of carbohydrates, fruits, vegetables, and proteins in the diet focused on achieving or maintaining good metabolic control\textsuperscript{36}. In this study, it was possible to adjust the dietary habits of the patients; studies\textsuperscript{9,37,38} show that readjustment of the carbohydrate intake could be related to the glycemic control obtained.

The main limiting factor in the study was the loss of glycemic and lipid data, since at the end of the intervention, data from only 702 patients (55%) were obtained. This is due to the fact that the PINEC is inserted into the CCSS health system; therefore, it has to adapt to the established procedures and resources of the institution for the control of patients with chronic diseases. For example, the prescription of laboratory examinations is only twice a
year, and it is exclusive from the attending physician. Furthermore, some areas where PINEC was developed do not have a clinical laboratory, so the patient had to move to the assigned facility which resulted in two outcomes: either the examination was performed but the patient did not withdraw the results or they did not perform it at all. In addition, during the intervention period, there was a lack of reagents.

Despite the limitations mentioned, PINEC identified that therapeutic education provides self-care tools to the user with diabetes, allowing them to assume control and responsibility for their disease. To give sustainability to this type of group educational interventions, the support of a multidisciplinary team and the existence of institutional and governmental strategies are of vital importance.

FINANCE SOURCE

This work was developed within the framework of the INCIENSA cooperation agreement. It was financed with public funds from the Government of Costa Rica.

ACKNOWLEDGMENTS

The authors would like to thank the professionals in Nutrition of the CCSS who implemented the PINEC in their work areas and to the patients.

DECLARATION ON CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest of a personal, financial, academic, institutional, or commercial nature.

REFERENCES