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Dietary Diversity Score (DDS) as a tool for diet management in patients with type 2 diabetes

Puntaje de Diversidad de la Dieta (PDD) como herramienta para el manejo de la dieta en pacientes con Diabetes Tipo 2.

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Abstract:

Dietary diversity Score (DDS) is known as an indicator of food quality. Quasi-experimental Study of intervention in 26 patients with Diabetes ((≤10 years of evolution, a body mass index (BMI) >25 kg/m2 and 40–59 years of age), from Hidalgo, México, divided into 2 groups of 13 randomly assigned patients (group 1, Food Plan Group (FPG) received an individualized food plan, group 2, Dietary Diversity Group (DDG) used the Dietary Diversity sheet. In both groups, it was determined: the adequacy and means of energy, carbohydrate, protein, lipid, and saturated fat intake using 24-hour recalls, Body weight, waist circumference (WC), DDS measured on 5 occasions, and HbA1c before and after the intervention. Energy inadequacy of 30% was observed in the FPG and 54% in the DDG (p=0.16); inadequate due to excess carbohydrate in 46.2% of GPA and 50.0% GDD (p=0.14); protein deficiency in 92% of the FPG and 69.2% of the DDG. Mean DDS in the FPG went from 5.0 to 6.0 (p=0.06) and in the DDG from 4.4 to 5.6 (p=0.01). Mean weight loss was −1.01 kg and 0.33 kg respectively (p=0.05). WC decreased from 98.8 ± 11.0 cm to 96.5 ± 11.5 cm (p=0.01) in the FPG and from 99.1 ± 5.7 to 98.03 ± 4.7 (p=0.26) in the DDG. The Food Plan was more efficient; however, the efficacy of food group counting cannot be ruled out in the long term since it is easier than counting calories or portions.

Keywords:

Dietary diversity, diabetes mellitus, nutritional adequacy, intervention

Resumen*:*

El Puntaje de Diversidad de la Dieta (PDD) es una medida competente del comportamiento dietético. Estudio Cuasi experimental de intervención en 26 pacientes con Diabetes (≤10 años de evolución, IMC >25 kg/m2, 40-59 años), de Hidalgo México, divididos en 2 grupos de 13 pacientes asignados al azar (grupo 1, Plan de Alimentación (GPA) recibió un plan individualizado de alimentación, grupo 2, Grupo Diversidad de la Dieta (GDD) usó la Hoja de Diversidad de la Dieta. En ambos se determinó: adecuación y medias de consumo de energía, carbohidratos, proteínas, lípidos y grasa saturada usando recordatorios de 24 horas, peso corporal, circunferencia de cintura (CC), PDD medidos en 5 ocasiones, y HbA1c pre y posterior intervención. Se observó inadecuación energética de 30% en el GPA y 54% en el GDD (p=0.16); inadecuación por exceso de carbohidratos en 46.2% del GPA y 50.0% GDD (p=0.14); deficiencia de proteínas en 92% del GPA y 69.2% del GDD. La media de PDD paso de 5.0 a 6.0 (p=0.06) en el GPA, y 4.4 a 5.6 (p=0.01) en el GDD. La media de pérdida de peso fue −1.01 kg y 0.33 kg respectivamente. La CC disminuyó de 98.8 ± 11.0 cm a 96.5 ± 11.5 cm (p=0.01) en el GPA y de 99.1 ± 5.7 a 98.03 ± 4.7 (p=0.26) en el GDD. El plan de alimentación fue más eficiente, sin embargo, no se descarta la efectividad del conteo de grupos a largo plazo, ya que es más sencillo que contar calorías o porciones.

***Palabras Clave*:**

Diversidad de la Dieta, diabetes mellitus, adecuación nutricional, intervención.

INTRODUCTION

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Nutrition is considered the cornerstone of effective management of type 2 diabetes mellitus (DM2).[1] Patients with this disease are expected to learn, with counseling from healthcare personnel, how to correctly select their food and develop a new and better lifestyle.[2] In Mexico, the official standard for the prevention, treatment, and control of diabetes mellitus recommends integral treatment of patients to comply with basic goals such as normal glucose, total cholesterol, triglyceride, blood pressure, weight, and glycosylated haemoglobin (HbA1c) levels. Among the non-pharmacological measures, there is nutrition, weight control, and a physical activity plan.[3]

Since the 1950s, the American Diabetes Association has proposed a system of equivalents as a tool for guiding the patient in understanding their food plan.[4] This consists of providing menus with the exact number of rations (daily calorie requirement) with the flexibility of being interchangeable for equivalent foods; in other words, food portions that have a nutritional content comparable to those of the same group (vegetables, fruit, legumes, foods of animal origin, milk, cereals, tubers, etc.) in quality and quantity.[5] This allows them to be interchangeable with each other.[6] The disadvantage of the food equivalent system used as a traditional method is the difficulty in understanding correct exchanges, in some cases, as well as the size and weight of the portions. In addition, while the individual learns his or her own menu, the nutritionist has to have several sessions with them. Despite this, not all patients learn, and they lose interest and abandon the plan. A study in Mexico mentioned that 87% of patients with obesity that followed the diet treatment abandoned it after a 10% advance and 33% abandoned it due to the stress caused by its implementation.[7] The limitations in identifying and understanding instructions regarding nutritional treatment harm its compliance; therefore, the tools used in nutritional consultation and orientation must help the patient achieve an adequate diet.[2] And in the long term, generate a change in behavior that is sustainable over time, which represents a great challenge. The information about knowing what to do, how to do it, and when to do it, through clear instructions, appropriate to their particular context or situation, as well as spending the necessary time to ensure their understanding, are strategies used by the nutritionist. However, for health education to be effective, in addition to the content, the form of communication must be considered and the understanding of the message to be transmitted must be ensured.[8]

The term food diversity Score (DDS) refers to the quantification of the number of food groups consumed in the diet, whether by an individual or a household, regardless of the amount consumed and during the reference period, usually the last 24 hours.[9] DDS has allowed a quick, simple, low-cost assessment of the diet, helping to obtain detailed information on food access in the home and adequate nutrition, the diet must meet the requirements of each individual.[10,11] The concept was introduced by the World Health Organization as a potential indicator of adequate nutrition that arose from the need for indicators capable of assessing the diet to improve child nutrition. It is a good predictor of adequate nutrition of at least 11 micronutrients, which are an indirect indicator according to a study carried out in women from five low-income countries.[12] When diets lack diversity and are dominated by basic foods, there is a high risk of inadequate consumption of micronutrients.[13] Consumption of a greater diversity of foods is associated with health benefits, achieving an increase in consumption, above all, of micronutrients, dietary fiber, and antioxidants[14], improving the composition of the intestinal microbiota and reflecting on immune function.[15, 16]

Under the premise that an adequate diet can be achieved with a diverse diet if the consumption of various food groups is intentionally encouraged as proposed by the World Health Organization´s DD scoring methodology, is it possible to achieve an adequate diet in the same manner as with the well-calculated food plan using the traditional method? For this reason, the aim of this study is to compare DDS as a tool for diet management to achieve greater nutritional adequacy, with the traditional method (a food plan) in patients with DM2.

MATERIAL AND METHODS

This was a quasi-experimental intervention in patients with type two Diabetes from Hidalgo, Mexico carried out from April to June 2018. Inclusion criteria were: disease evolution ≤10 years, a body mass index (BMI) ≥25 kg/m2 and 40–59 years of age. Patients with nutritional treatment at another health care service were excluded. Patients who did not have an attendance ≥80% of sessions or who changed residence were eliminated.

The protocol was approved by the Hidalgo Health Services Ethics and Research Committee, with the folio number FSSA2017068 on February 27, 2018; under current regulations, the participants previously signed a written informed consent, keeping their personal data and information management confidential. All study procedures conform to the Declaration of Helsinki. In accordance with the Regulations of the General Health Law on Health Research, Second Title, Chapter I, Article 17, it is research with Minimal Risk.

The sample was for convenience of 60 patients summoned from 4 Health Centers of Hidalgo, matched by sex and age divided into two groups: 30 patients, intervention group that would receive 5 sessions of dietetic education and would use as a tool of the nutrition consultation the Dietary Diversity sheet. 30 patients, a control group that would also receive 5 sessions of dietary education and would use individualized menus as a tool for nutrition consultation. The members of each group were randomly selected through red and blue chips that will

determine which group they will belong to. 60 patients were called under the inclusion criteria, 56 attended, 24 were eliminated and 6 abandoned the study. The final sample was 26 patients (13 in each group).

During the baseline assessment, the following information was requested: age, years of education, years of DM2 disease evolution, physical activity (sedentary, mild, moderate, intense), as well as the following measures to evaluate the intervention through the variables discussed below.

DIETETIC

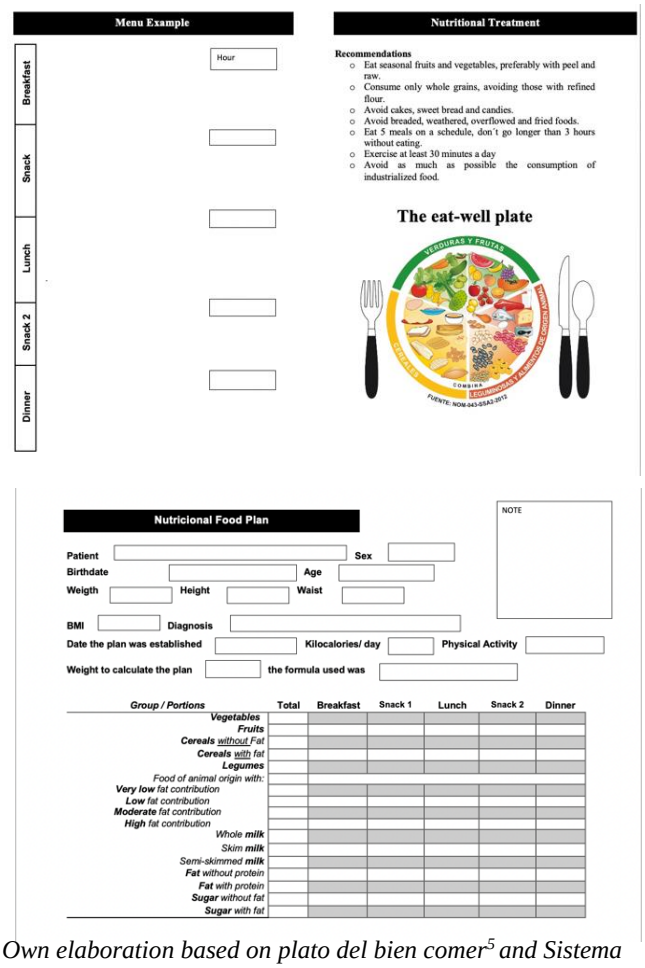
The percentage of adequate nutrition was determined, energy, macronutrients (carbohydrates, proteins, and lipids), saturated fat, fiber, and sugar, using a 24-hour dietary recall (baseline, 3 intermediates, and one final); for this, food models, cups and standard measures were used. The calculation of the Recommended Daily Energy Intake (DEI) was made in accordance with the Official Mexican Standard 043-SSA2-2012.[5] Men with normal physical activity or very physically active women, 30 kcal/kg of body weight; women with normal physical activity and men with a sedentary lifestyle or over 55 years of age active, 25-28 kcal/kg; sedentary women and sedentary men over 55 years of age, 20 kcal/kg, in accordance with the Official Mexican Standard 015-SSA2-2010.[3] Macronutrient adequacy was determined according to the standard with a reference distribution of 50% carbohydrates, 25% proteins, and 25% fats. The recommendations for saturated fats, fiber ≥25 g/day, and sugar ≤50 gr/day, were used.

The Dietary Diversity Score (DDS) proposed by the World Health Organization for measuring individual nutritional adequacy was used.[9] A score of one (1) was assigned if the group was consumed and zero (0) if it was not. The DDS was the sum of 9 categories: 1) starches (cereals, roots, and white tubers), 2) dark green leafy vegetables, 3) other fruits and vegetables rich in vitamin A, 4) other fruits and vegetables, 5) organ meats, 6) meat and fish, 7) eggs, 8) legumes-nuts-seeds, 9) milk and dairy products. Group diversity (GD) was also calculated; the total number of foods of the same group in one day, in the groups: fruits, vegetables, cereal,s and products of animal origin (PAO).[16]

ANTHROPOMETRICS

Body weight was measured to assess weight loss during the intervention. Height was also measured to calculate BMI. For this, A SECA® model 874 scale was used together with a SECA® 217 stadiometer (SECA 874) (Seca GmbH & Co. KG, Hamburg, Germany); BMI was classified as overweight (24.9-29.9 kg/m2) and obese (>30 kg/m^2). Waist circumference (WC) was measured in centimeters with a SECA 201 fiberglass tape measure. All measures were evaluated three times more and at the end of the intervention. Also, two measures of glycosylated hemoglobin (HbA1c) were made at the start and end of the intervention. A cutoff point of ≤7.0%, in control, and >7.1%, poor control, was used.[17]

Figure 1. Tool* used in the control group (Food Plan Group, FPG), with calculation of calories and macronutrients, distribution of equivalents, and sample menu design in consultation.



Own elaboration based on plato del bien comer[5] *and Sistema Mexicano de Alimentos Equivalentes.*[6]

INTERVENTION

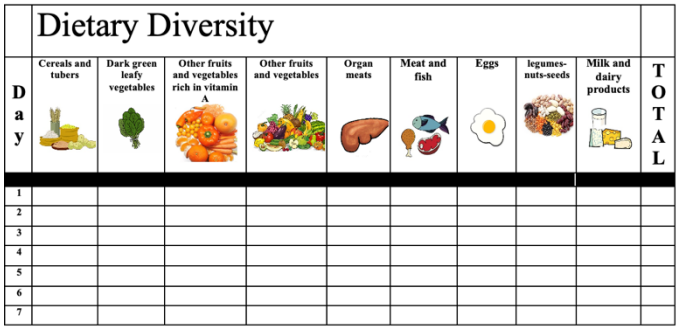
Random sampling was used to form the control group, called the Food Plan Group (FPG), in which calorie requirements and distribution of equivalents were calculated using the Mexican Food Equivalent System[6] with menus prepared with the patient in consultation (figure 1); the second group was called the Dietary Diversity Group (DDG) that used the food diversity tool integrated with 9 food groups (figure 2). In both groups, five individualized appointments were carried out, reviewing 5 topics in workshops, approximately 30-45 minutes long. The topics were "food groups" (9 diversity groups, Mexican Food Equivalent System), "unhealthy groups",[18] "snacks versus prolonged fasting", "considerations regarding walking for

weight loss", and "reading food labels." Patient attendance to each appointment was recorded.

STATISTICAL ANALYSIS

Food Processor Nutrition Analysis Software was used for nutritional analysis. Data were collected with SPSS version 24 for Windows. Means and standard deviations were calculated. Pearson's chi-squared test and the Kruskal Wallis test were used for statistical analysis with a significance of $p<0.05$.

Figure 2. Tool used in the experimental group (Dietary Diversity Group, DDG): Dietary Diversity sheet for counting groups consumed per day.



Own elaboration based on: Kennedy G. Et, al. [9]

RESULTS

A total of 26 patients were evaluated; 13 patients per group with 92.3% women and 7.7% men in each. Mean ages were 51±5.6 years in the FPG group and 50.7±5.7 years in the DDG group ($p<0.90$). The mean number of years of evolution with DM2 for both groups was 4 (±3.5 for the FPG and ±2.9 for the DDG) ($p<0.92$). 38.5% of the FPG and 30.8% of the DDG were classified as sedentary, 46.2% of the FPG and 61.5% of the DDG had mild, and 15.4% of the FPG and 7.7% of the DDG, moderate ($p<0.69$) physical activity. 38.5% of the FPG and 30.8% of the DDG were classified as overweight; 61.5% and 69.2% respectively, were obese. Mean attendance to sessions was 4.6 from a total of 5 in both groups ($p<0.76$).

Table 1 shows the means and standard deviations of energy consumption, carbohydrates, proteins, lipids, saturated fat, fiber and sugar by 24-hour recall (R24), by group with their statistical significance, as well as the mean of all the reminders. Table 2 shows the insufficiency, adequacy or excess of the mean energy consumption of patients, and their differences by group. The same is shown for the consumption of proteins, carbohydrates, lipids, saturated fat, fiber, and sugar.

Regarding the mean groups consumed in the diet, the FPG went from a consumption of 5.5 to 6 groups in DDS ($p=0.06$); the DDG went from 4.4 to 5.6 ($p=0.01$). In Group Diversity (GD), fruit diversity went from 1.5 to 2.1 ($p=0.15$) in the FPG and from 1.0 to 2.1 in the DDG ($p=0.02$).

Table 1. *Nutritional adequacy of the mean 24-hour recalls by study group.*

	General n=26	FPG n=13	DDG n=13	p-value
	%	**%**	**%**	
Energy				
Insufficient	30.8	30.8	30.8	0.16
Adequate	57.7	69.2	46.2	
Excess	11.5	0	23.1	
Protein				
Insufficient	92.3	92.3	92.3	1.00
Adequate	7.7	7.7	7.7	
Carbohydrates				
Insufficient	19.2	7.7	30.8	0.14
Adequate	30.8	46.2	15.4	
Excess	50	46.2	53.8	
Lipids				
Insufficient	38.5	46.2	30.8	0.17
Adequate	38.5	46.2	30.8	
Excess	23.1	7.7	38.5	
Saturated fat				
Insufficient	80.8	92.3	69.2	0.06
Adequate	30.8	0	30.8	
Excess	0	7.7	0	
Sugar				
≤50 g/day	42.3	38.5	46.2	0.5
>50 g/day	57.7	61.5	53.8	
Fiber				
≥25 g/day (%)	73.1	7.7	7.7	1.00
<25 g/day (%)	11.5	92.3	9.3	

FPG, food plan group; DDG, Dietary Diversity Group
X^2 de Pearson

In the FPG, vegetable consumption went from 2.1 to 2.3 (p=0.60); in the DDG, it went from 1.1 to 2.0 different vegetables consumed in one day (p=0.38). Cereals were recorded as 3.4 and 3.2 (p=0.62) in the FPG, and 3.4 and 3.0 in the DDG (p=0.62). Products of animal origin went from 1.6 to 2.3 different types in the FPG (p=0.14) and from 1.6 to 1.8 (p=0.41) in the DDG. Table 3 breaks down DDS consumption by group.

Regarding the anthropometric measurements, mean weight loss was −1.01 kg in the FPG and 0.33 kg in the DDG (p=0.05); the behavior between measurements is shown in Table 4. The mean value of the WC in the FPG was 98.8 ± 11.0 cm, which decreased to 96.5 ± 11.5 cm in the final measurement (p=0.01). The DDG showed a mean WC value of 99.1 ± 5.7 which decreased to 98.03 ±4.7 in the final measurement (p=0.26). Finally, regarding the patients considered in glucose control (HbA1c ≤7.0%), in the initial measurement, 53.8% were in control and 46.2% had poor control in both groups. In the final measurement, 92.3% of the FPG and 69.2% of the DDG were classified as in control, and 7.7% of the FPG and 30.8% of the DDG (p=0.32) were classified with poor control.

DISCUSSION

The individual Dietary Diversity Score is a successful tool in the exploration of dieting patterns and a competent measure of dieting behavior beneficial to health.[11, 16] The Food Diversity Sheet tool was designed to teach patients to count the food groups in their diet to avoid counting calories or portions, which is more complex. A high diversity of groups, at least four of nine, correlates with greater individual dietetic adequacy.[11, 12, 19]

After applying the two tools, both the FPG (5 to 6 groups, p=0.06) and the DDG (4.4 to 5.6, p=0.01) presented an increase of one group more in their diet with regard to the initial measurement. This highlighted the result since knowing that a patient, for example, consumes four different food groups implies that their diets offer diversity in macro and micronutrients. It is much more valuable to know that a patient consumes four different foods, which could be only cereals. Although it was not possible to know exactly the group that increased, certain consumption trends were found. For example, the “dark green leafy vegetables” group registered a progressive increase in the proportion of patients who included them in their diet during the intervention, especially in the FPG (38.5%, 61.5%, 77.8%, and 84.6%) (Table 3). The same happened in the DDG with “other fruits and vegetables” (53.8%, 46.2%, 66.7%, 76.9%). A progressive increase in the mean value of fiber consumption was also observed; in the FPG, from 15.0 g at baseline to 18.0 g reported in the final recall (p=0.11), and in the DDG from 14.9 g to 18.0 g (p=0.39) (Table 2). Even so, this was still below the recommendation (<25 g/day), recording this as inadequate in 92% of the participants in both groups, depriving themselves of its important function in the digestive system. Normally, high fiber content is found in dry foods such as whole grains, vegetables, and dry fruit.[20] In Mexico, it has been reported that 65% of adults do not meet the daily recommended intake and there is also a low consumption of fruit and vegetables at all ages.[21] People usually consume monotonous diets dominated by refined cereals and poor consumption of fruits and vegetables, associated with multiple nutrient deficiencies such as fiber.[19]

The main objective of this study was to compare adequate nutrient consumption. For this, the mean R24 was used to reduce the effect of intraindividual variability in daily consumption.[22, 23] Although all patients with the meal plan would be expected to follow and maintain adequate calorie intake, only 70% did. For the DDG, it was only 46%, a little less than half (p=0.16). In addition, in the DDG, in 23.1% of patients, inadequacy due to excess was observed, a category that was absent in the meal plan. It is known that a higher energy intake is a significant predictor of higher HbA1c levels, and higher HbA1c levels are associated with an increased risk of complications and the presence of other diseases.[17, 24]

Although calorically, the adequacy difference favors the group with the Food Plan, in the analysis of macronutrient adequacy, this was not so. Carbohydrates were the energy substrate with the greatest inadequacy due to excess, at least in half of the patients in the two groups (46.2% FPG and 50.0% DDG). Regarding these types of diets, high in carbohydrates, a systematic review evaluated the efficacy of nine different dietary approaches, concluding that a low carbohydrate diet was the best approach to reduce HbA1c levels in patients with DM2 (84%), compared to a control diet (habitual).[25] A traditional pattern in Mexico has been characterized by a low FD with foods from corn representing 47% of the energy intake.[26] Likewise, the exchange of whole grains (rich in fiber) for energy-refined, low-cost cereals such as white bread and instant noodles has been observed.[27, 28]

On the other hand, proteins were the substrate with the greatest inadequacy due to deficiency in the two groups (92.3%). The “meat and fish” group of the DDS was present in 76% to 92% of the participants throughout the intervention, similar to the “milk and dairy” group with >60% (Table 3). This suggests that the consumption of foods that provide proteins, especially those of high biological value, is present but in low quantity and it fails to meet the requirements. It is important to point out that the mean value of protein consumption was similar in the two groups (about 60 g). Regarding the adequacy of fats, although not statistically significant, the DDG (38.5%) had a greater number of participants with inadequacy due to excess than the FPG (7.7%, p=0.17). Regarding saturated fats, a high percentage of patients with inadequacy due to deficiency (92.3% FPG and 69.2% DDG (p=0.06), possibly linked to the

low consumption of animal products, was noted. The mean values of lipids and saturated fat showed no significant difference for R24, except in recall number two.

Table 2. *Mean energy and nutrient values for each 24-hour recall by study group Mean (SD*).

	Group	Baseline R24	R24 2	R24 3	R24 4	R24 5	Mean
		X ±(SD)	X ±(SD)	X ±(SD)	X ±(SD)	X ±(SD)	X ±(SD)
Energy (kcal/day)	FPG	1402 ± 401	1517 ± 505	1363 ± 277	1361 ± 410	1361 ± 410	1425 ± 227
	DDG	1460 ± 458	1679 ± 358	1526 ± 544	1270 ± 439	1270 ± 439	1456 ± 319
Protein (g)	FPG	58.6 ± 19	65 ± 21	61 ± 24	61 ± 22	57 ± 57	60 ± 12
	DDG	69.3 ± 42	71± 19	68 ± 25	46 ± 21	56 ± 56	63 ± 15
Carbohydrates (g)	FPG	207.8 ± 207	229± 111	185 ± 185	201 ± 51	201 ± 51	209 ± 41
	DDG	199 ± 199	220 ± 63	224 ± 224	200 ± 94	200 ± 94	209 ± 53
Lipids (g)	FPG	33.1 ± 16	**38 ± 38***	43 ± 17	35 ± 12	37 ± 25	38 ± 11
	DDG	40.0 ± 20	**56 ± 56***	39 ± 24	34 ± 18	28 ± 11	40 ± 11
Saturated fat (g)	FPG	8.6 ± 6	**8.0 ± 6***	8.0 ± 5	8.0 ± 3	9.0 ± 7	8.0 ± 4
	DDG	9.0 ± 5	**15.0 ± 7***	10.0 ± 6	6.0 ± 4	7.0 ± 5	10 ± 3
Fiber (g)	FPG	15.0 ± 6.7	22 ± 15	18 ± 7	19 ± 7	19 ± 7	18 ± 7
	DDG	14.9 ± 6.4	17 ± 7	19 ± 8	18 ± 13	18 ± 13	17 ± 6
Sugar (g)	FPG	56.6 ± 45.6	74 ± 48	49 ± 27	71 ± 33	56 ± 29	60 ± 22
	DDG	43.6 ± 27.3	44 ± 27	47 ± 30	64 ± 69	66 ± 43	52 ± 23

FPG, food plan group; DDG, Dietary Diversity Group.
R24, 24-hour recall; SD, Standard Deviation.
Kruskal Wallis Test p<0.05

Table 3. *Proportion of patients by study group who consumed or not the 9 groups of Dietary Diversity*.

Food group	Baseline Measure		Measure 1		Measure 2		Measure 3		Final measure	
	FPG	DDG	FPG	DDG	FPG	DDG	FPG	DDG	FPG	DDG

	%	%	%	%	%	%	%	%	%	%
Cereals and tubers										
Yes %	100	100	100	100	100	100	100	100	100	100
Dark green leafy vegetables										
Yes %	38.5	38.5	61.5	69.2	61.5	61.5	77.8	55.6	**84.6**	**46.2***
No %	61.5	61.5	38.5	30.8	38.5	38.5	22.2	44.4	**15.4**	**53.8***
Fruits and vegetables rich in vitamin A										
Yes %	53.8	30.8	69.2	53.8	53.8	46.2	44.4	66.7	76.9	76.9
No %	46.2	69.2	30.8	46.2	46.2	53.8	55.6	66.7	23.1	23.1
Other fruits and vegetables										
Yes %	76.9	53.8	84.6	76.9	76.9	84.6	100	55.6	76.9	76.9
No %	23.1	46.2	15.4	23.1	23.1	15.4	0	44.4	23.1	23.1
Organ meats										
No	100	100	100	100	100	100	100	100	100	100
Meat and fish										
Yes %	84.6	76.9	92.3	84.6	76.9	84.6	100	77.8	92.3	92.3
No %	15.4	23.1	7.7	15.4	23.1	15.4	0	22.2	7.7	7.7
Egg										
Yes %	30.8	38.5	15.4	23.1	23.1	23.1	22.2	22.2	**38.5**	**46.5***
No %	69.2	61.5	84.6	76.9	76.9	76.9	77.8	77.8	**61.5**	**53.8***
Legumes, nuts, and seeds										
Yes %	53.8	52.8	46.2	53.8	53.8	76.9	44.4	33.3	61.5	59.2
No %	46.2	46.2	53.8	46.2	46.2	23.1	55.6	66.7	38.5	30.8
Milk and dairy										
Yes %	69.2	53.8	61.5	76.9	100	69.2	100	66.7	76.9	53.8
No %	30.8	46.2	38.5	23.1	0	30.8	0	33.3	23.1	46.2

*FPG, food plan group; FDG, Dietary diversity Group. *p<0.05*

Table 4. *Difference in the means of weight loss during the intervention.*

Difference in means	Group	Mean	SD	P-valor	upper	lower
Weight 1 and baseline	FPG	-0.18	0.81	0.29	-1.29	0.41
	DDG	0.26	1.25			
Weight 2 and baseline	FPG	-0.1	0.9	0.76	-0.94	0.71
	DDG	0.02	1.14			
Final weight and baseline	FPG	-1.06	1.98	0.05	-2.82	0.04
	DDG	0.33	1.53			

FPG, food plan group; FDG, Dietary diversity group; SD, standard deviation. t-test for related samples, 95% CI.

A recent study concluded that the replacement of saturated fatty acids (such as meat, eggs, blue fish, and dairy) by polyunsaturated products (such as olive oil, avocado, olives, almonds, etc.), result in a positive modification of several genes involved in lipogenesis, cholesterol metabolism, β-oxidation and inflammation.[29]

In this study, it is suggested that the adequacy of energy in the FPG (70%) and the high inadequacy of saturated fat, resulted in a greater weight loss (−1.06 kg ± 1.98) than in the DDG (0.33 kg ±1.53) (p=0.05).

In the same way, the FPG lost more waist centimeters on average (2.3 cm, p=0.02), than the DDG (1.07 cm, p=0.27). It should be noted that although to a lesser extent, weight and waist loss had a positive trend in the DDG, despite all the limitations of the tool, such as not handling portions, justifying the high caloric inadequacy due to excess, and the absence of an example menu that would guide the patient in the selection of food. Therefore, it is suggested that, in the long term, when the number of groups increases or the diversity within the groups increases, it is possible that repeated foods such as cereals will decrease, improving these anthropometric indicators. A study conducted with Iranian students observed an inverse relationship between greater diversity and central adiposity. Likewise, a lower prevalence of obesity was reported among individuals in the upper category of diversity than in the lower category. This emphasizes that a higher diversity score was associated with a healthier diet, and those in the upper category also consumed less fatty foods, and refined grains and more fruits, vegetables, and whole grains. Higher diversity was also positively associated with total dietary fiber intake.[30] At the end of the intervention, both groups decreased the proportion of patients with poor glycemic control, again with greater success in the FPG, from 46.2% to 7.7%, while the DDG went from 46.2% to 30.8%.

CONCLUSION

Although the results of the FD tool were much more modest than those of the Food Plan, it was possible to see positive changes in HbAC1, with no differences in the FPG. Energy adaptation was better with the food plan, but the distribution of macronutrients was similar in both groups. Carbohydrates were the substrate with the greatest inadequacy due to excess and proteins and the substrate with the greatest inadequacy due to deficiency; the difference seemed to be in fat consumption, a high inadequacy in the consumption of saturated fat. FD increased in one group with the two tools, and in the two groups, a progressive improvement in the consumption of some vegetables and fruits was observed.

Being a graphic tool, the Food Diversity sheet tool could be used successfully in patients with low schooling[31], where it is not feasible to guide them through a meal plan with the equivalent system; therefore, it is suggested to evaluate the Food Diversity sheet in these conditions. On the other hand, it could be argued that the tool "the plate of good eating",[5] is the same since it is graphic; however, the difference lies in the breakdown of fruits and vegetables, attributing value because of their nutrient and for their colors, becoming dynamic and clearer. Considering that in Mexico the consumption of this type of food shows great deficiencies, it is considered that this tool can benefit an increase in the intake of dietary fiber and metabolites of secondary plants, such as flavonoids and carotenoids, which are known to have beneficial effects on health.

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