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Impact of Different Nutritional Approaches on Glycemic Control and Comorbidities among Patients with Type 2 Diabetes

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Abstract: **Background: Type 2 diabetes accounts for more than 90% of patients with diabetes and leads to microvascular and macrovascular complications that cause profound physical and psychological distress upon patients and put a huge burden on health-care systems. Nutritional management is an integral part of diabetes control and prevention of complications.**

Aim: To investigate the impact of different nutritional approaches on glycemic control and comorbidities among patients with type 2 diabetes.

Methods: a prospective comparative study of 90 patients with type 2 diabetes with a duration of 3- 5 years from the onset of diagnosis were categorized into 3 groups according to their diet preference, which includes, caloric control diet, Ketogenic diet, Plant-based diet.

Results: there was a statistically significant difference between studied patients' BMI with caloric control diet after 3 and 6 months while there was no statistical significance difference between BMI and ketogenic or plant-based diet after 3 and 6 months. There was a statistically significant difference between studied patients' Hba1c with caloric control and plant-based diet only after 6 months.

Conclusion: Adherence to the nutritional management plan for patients with type 2 diabetes is a key factor for better health status. A caloric control diet is the best for patients with type 2 diabetes.

***Keywords*: nutritional approaches, glycemic control, type 2 diabetes.**

1. BACKGROUND

Type 2 diabetes, the most common type of diabetes, is a disease that occurs when a patient's blood glucose, or blood sugar, is too high. In type 2 diabetes, the patient's body doesn't make enough insulin or doesn't use insulin well. Too much glucose then stays in patients' blood, and not enough reaches their cells. 415 million people live with diabetes worldwide, and an estimated 193 million people have undiagnosed diabetes. Patients are more likely to develop type 2 diabetes if they are age 45 or older, have a family history of diabetes, African American, Alaska Native, American Indian, Asian American, Hispanic/Latino, Native Hawaiian, or Pacific Islander, have high blood pressure, have a high level of triglycerides, are not physically active, have a history of heart disease or stroke, have psychological upset. Type 2 diabetes accounts for more than 90% of patients with diabetes and leads to microvascular and macrovascular complications that cause profound psychological and physical distress to both patients and carers and put a huge burden on health-care systems. Complications for patients with type 2 diabetes include cardiovascular disease, nerve damage (neuropathy), Kidney damage (nephropathy, eye damage (retinopathy), foot damage, skin conditions, hearing impairment, Alzheimer's disease, and psychological upset including depression (ChatterjeeMD[ab], 2017).

Diabetes is diagnosed with fasting sugar blood tests or with (A1c) blood tests, also known as glycated hemoglobin tests. A fasting blood sugar test is performed after patients have had nothing to eat or drink for at least eight hours. Normal fasting blood sugar is less than 100 mg/dl (5.6 mmol/l). An A1c test should be performed in a laboratory using a method that is certified by the National Glycohemoglobin Standardization Program (NGSP) and standardized to the Diabetes Control and Complications Trial (DCCT) assay. Normal range (A1c) is less than 5.7, pre-diabetes is considered when A1c ranged from 5.7 - 6.4% and diabetes is diagnosed when A1c 6.5% or higher. Results from randomized trials support a range of

interventions that target isolated risk factors such as elevated levels of glycated hemoglobin, blood pressure, and cholesterol to prevent or postpone complications of type 2 diabetes (Aidin Rawshani, 2018).

Despite increasing knowledge regarding risk factors for type 2 diabetes and evidence for successful prevention programs, the incidence and prevalence of the disease continues should be rise globally. For individuals with type 2 diabetes mellitus or the metabolic syndrome, adherence to medication regimen including hypoglycemic drugs and an idealized dietary pattern can drastically alter the risk and course of these chronic conditions. Every patient has different dietary needs. Doctors formulate individualize diet plans based on current eating habits, preferences, and a target weight or blood sugar level for that patient. Target levels of carbohydrate intake should approximate 30% of consumed calories. Healthy food choices should include copious fruits, vegetables, and nuts while minimizing foods with high glycemic indices, especially processed foods (Via MA& Mechanick, 2016).

Reducing carbohydrate intake to a certain level, typically below 50 g per day, leads to increased ketogenesis in order to provide fuel for the body. Such low-carbohydrate, ketogenic diets were employed to treat obesity and diabetes in the 19th and early 20th centuries. Recent clinical research has reinvigorated the use of the ketogenic diet for individuals with obesity and diabetes. Although characterized by chronic hyperglycemia, the underlying cause of T2DM is hyperinsulinemia and insulin resistance, typically as a result of increased energy intake leading to obesity. The ketogenic diet substantially reduces the glycemic response that results from dietary carbohydrate as well as improves the underlying insulin resistance. This review combines a literature search of the published science and practical guidance based on clinical experience. (Eric, et. al. 2018)

Plant-based diets are eating patterns that emphasize legumes, whole grains, vegetables, fruits, nuts, and seeds and discourage most or all animal products. Cohort studies strongly support the role of plant-based diets, and food and nutrient components of plant-based diets, in reducing the risk of type 2 diabetes. Evidence from observational and interventional studies demonstrates the benefits of plant-based diets in treating type 2 diabetes and reducing key diabetes-related macrovascular and microvascular complications.

Ketogenic diet severely restricts carbohydrates. It forces the body to break down fats for energy. The process of using fat for energy is called ketosis. It produces a fuel source called ketones. A ketogenic diet may help some people with type 2 diabetes because it allows the body to maintain glucose levels at a low but healthy level. ketogenic diets can be helpful in controlling levels of HbA1c. This refers to the amount of glucose traveling with hemoglobin in the blood over about 3 months. The ketogenic diet helps the body burn fat. This is beneficial when a person is trying to lose weight, and it may be helpful for people whose excess weight has influenced the development of prediabetes and type 2 diabetes. (Craig, Winston J., 2019).

Diabetic nurse has an important role and clear responsibilities when treating patients with diabetes. Nursing care planning goals for patients with diabetes include effective treatment to normalize blood glucose and decrease complications using insulin replacement, balanced diet, and exercise. The nurse should stress the importance of complying with the prescribed treatment program. Tailor your teaching to the patient's needs, abilities, and developmental stage. Stress the effect of blood glucose control on long-term health.

2. AIM AND HYPOTHESIS

Aim:

The aim of this study was to investigate the impact of different nutritional approaches on glycemic control and comorbidities among patients with type 2 diabetes.

Research Hypotheses

To achieve the aim of the study, the following hypotheses were postulated to be tested:

H1: There will be a significant difference in selected variable after adhering to caloric control diet among patients with type 2 diabetes.

H2: There will be a significant difference in selected variable after adhering to plant base diet among patients with type 2 diabetes.

H3: There will be a significant difference in selected variable after adhering to ketogenic diet among patients with type 2 diabetes.

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3. RESEARCH DESIGN

Research design:

A quasi experimental research design was utilized in the current study.

Setting:

This study was conducted in different diabetes out patients clinics affiliated to different governmental hospitals in Cairo – Egypt.

Sample:

A purposive sample consisting of 90 patients with type 2 diabetes were included. This number was calculated using a power analysis and recruited to this study according to the following inclusion criteria.

a) Conscious adult male or female patients.

b) Had an age range between 18 to 55 years.

c) Able to communicate through talking.

d) free from mental problems or any cognitive impairments that would prevent them from sharing their self- experiences

e) Agreed to participate in the study.

f) Able to sign a consent form.

Tools of Data Collection

In the current study researchers used one tool to collect data, this tool is divided to two parts. Part one to collect patients' personal data which include patient's code, age, gender, place of residence, …etc. Part two designed to assess selected variables for patients with type 2 diabetes which include BMI, HA1c and presence of other comorbidities.

Tools Validity and Reliability

Face and content validity of the study tool was tested by panel of three experts' faculty members in Medical Surgical Nursing field from Faculty of Nursing Cairo University. Reliability of the study tools were tested using test-retest = (0.8).

Pilot Study

A pilot study was conducted on 10 patients with the same inclusion criteria to ensure the feasibility of the study and the study tools for data collection, as well as to examine issues related to the research design, time required to fill out the sheet. Based on feedback taken from the pilot study there were no modifications done in the study tool. The pilot study was included in the study sample.

Ethical consideration:

An official permission were obtained from hospitals administrators to conduct the study. The purpose and nature of the study as well as the importance were explained to the patients who met the inclusion criteria. Signed consent was obtained from the patients who choose to participate in the study. Also, anonymity and confidentiality were assured through coding the data. Patients were assured that participation in this study was voluntary and they have the right to withdraw from the study at any time without penalty.

Methods:

The study was conducted on four phases; assessment, planning, implementation, and evaluation phase. Assessment phase involves collecting data through reviewing the literature dating back to at least 5 years using scientific data base**.** Planning phase; based on the outcome of the assessment phase, final format of the study tools were developed. Final decision about time, frequency, of patients' interview was develop. Implementation phase was started from November 2018 to July 2019, researchers conducted a prospective comparative study of 90 patients with type 2 diabetes with selected inclusion criteria were categorized into 3 equal group according to their diet preference which include caloric control diet, ketogenic diet,

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and plant based diet. At baseline, the following items were assessed heamoglobin A1C, lipid profile and disease burden symptoms (using study tool), then followed by two other assessments; 3 months and 6 months later using the same study tool. Evaluation phase; after finishing, the collected data were analysed statistically to identify the impact of of different nutritional approaches on glycemic control and comorbidities among patients with type 2 diabetes.

Data analysis:

Collected data was tabulated, computed, and analyzed using SPSS, version 20. Descriptive statistics including frequency distribution, percentage, means and standard deviations also correlational test such as t test and qui-square were use.

4. RESULTS

Part (1) Personal characteristics among the studied patient (figures 1-4)

Figure (1) illustrates that; regarding studied patients' age, almost of two thirds of the studied patients were in age range between 28 to less than 38 years the mean age is (33.66 ± 0.583).

Figure (1) studied patients' age

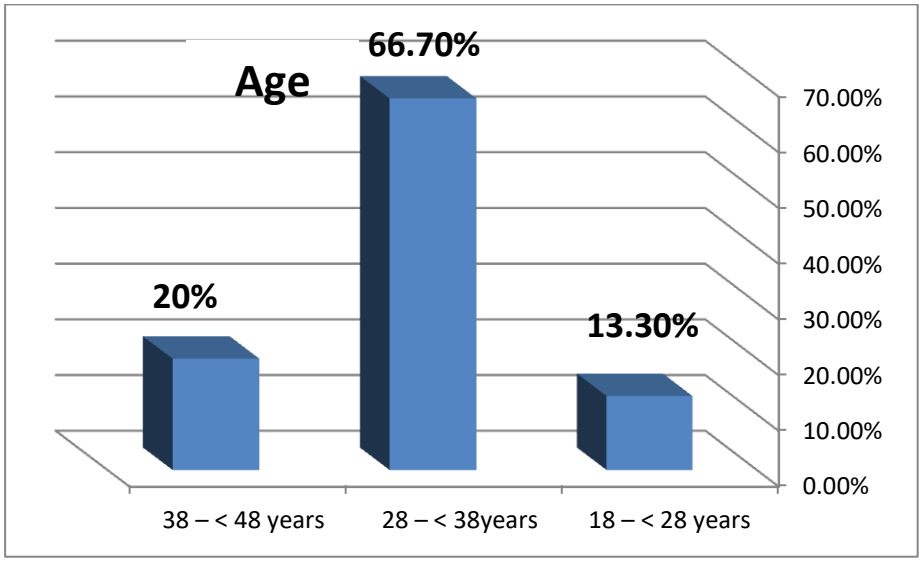

Figure (2) demonstrates that; more than half of the studied patients were male.

Figure (2): studied patients' gender

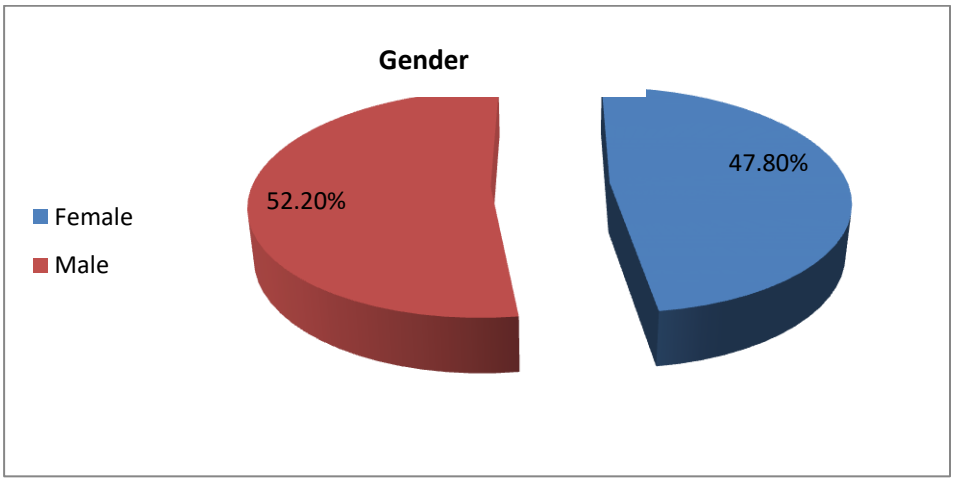

Figure 3 shows that; regarding educational level 26.7% and 23.3% of the studied patients were university degree and secondary degree respectively.

Novelty Journals

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Vol. 8, Issue 2, pp: (282-292), Month: May - August 2021, Available at: www.noveltyjournals.com

Figure (3): studied patients' educational level

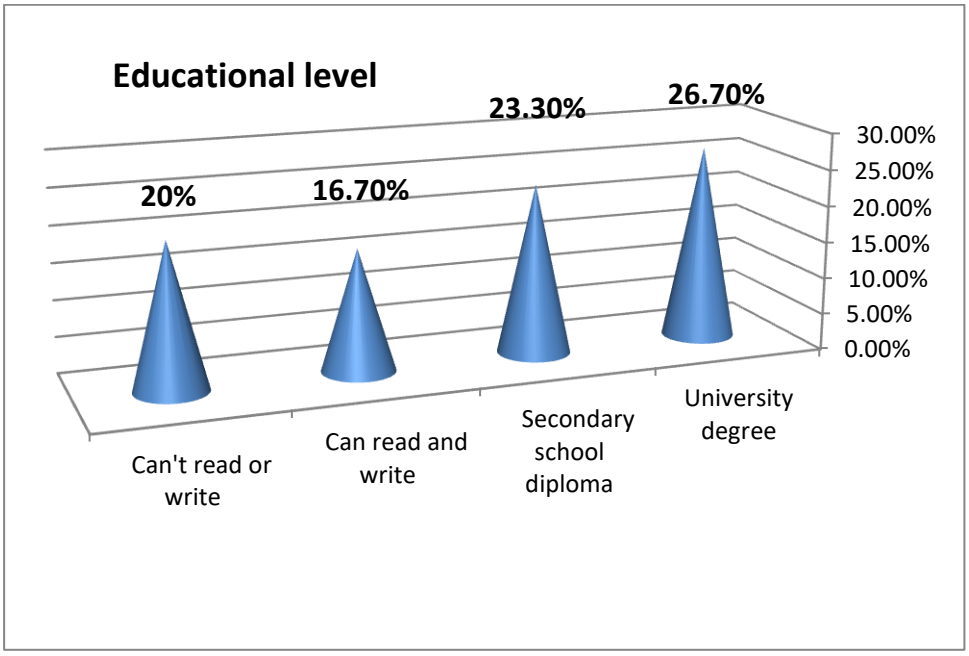
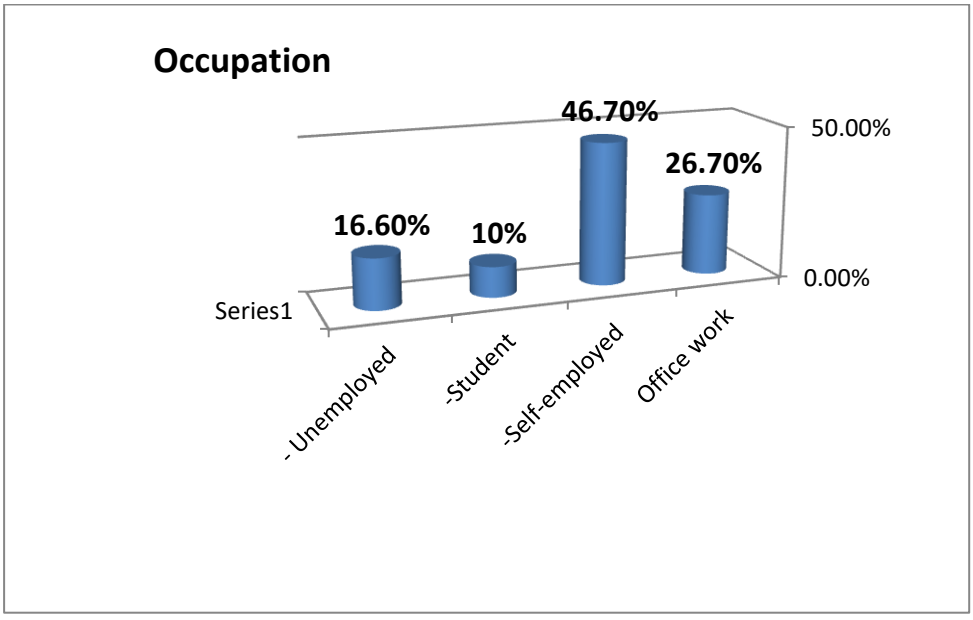


Figure (4) demonstrates that; regarding to occupation 46% of the studied patients were self-employed and 26.7% have office work.

Figure (4): studied patients' occupation



Part (2) Medical characteristics among the studied patient (Table 2)

Table (2) describes that; 44.4% of them had diabetes from 0 < 3 years and 50% of them had heart disease/coronary artery disease. 70% of the studied patients had no hypertension. According to presence of stroke/ transient ischemic attack, 90% of the studied patients their answer were no and (63.3% and 66.7%) of them had no peripheral vascular disease or neuropathy respectively.

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(Table 2.1): Frequency and percentage distribution of medical characteristics among the studied patients (n = 90).

Item	No.	%
Duration of diabetes		
0 < 3 years	50	44.4
3 -5 years	40	55.6
Heart disease/ coronary artery disease		
Yes	45	50
No	45	50
Hypertension		
Yes	27	30
No	63	70
Stroke/ Transient Ischemic attack		
Yes	9	10
No	81	90
Peripheral vascular disease		
Yes	33	36.7
No	57	63.3
Neuropathy		
Yes	30	33.3
No	60	66.7

Table (2.2) illustrates that; (75.6%, 63.3%, 72.2%, 70%, and 63.3%) of the studied patients had no (nephropathy, liver disease, retinopathy, smoking, or cheats disease) respectively. According to type of diet (33.3%, 33.3%, and 33.3%) of thee studied patients were use (ketogenic, caloric control and plant based diet) respectively.

(Table 2.2): Frequency and percentage distribution of medical characteristics among the studied patients (n = 90).

Item	No.	%
Nephropathy		
Yes	22	24.4
No	68	75.6
Liver disease		
Yes	33	36.7
No	57	63.3
Retinopathy		
Yes	25	27.8
No	65	72.2
Smoking		
Yes	27	30
No	63	70
Cheats disease		
Yes	33	36.7
No	57	63.3
Type of diet		
Ketogenic	30	33.3
Caloric control	30	33.3
Plant based	30	33.3

Part (3) Correlational Data among Different Studied Patients' Variables (Tables 3 - 9)

Table (3) demonstrates that; there were statistically significance difference between studied patients' Hba1c with caloric control and plant based diet only after 6 months and there were no statistical significance difference between Hba1c and ketogenic diet after 3 or 6 months.

International Journal of Novel Research in Healthcare and Nursing
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Table 3: Correlation between type of diet & Hba1c after 3 months and 6 months among the studied patients (n = 90).

Item	t	P. value
- Type of diet & Hba1c after 3 months	38.200	.370
- Type of diet & Hba1c after 6months	50.100	.044
- Ketogenic diet & Hba1c after 3 months	7.411	.077
- Ketogenic diet & Hba1c after 6 months	6.097	.257
- Caloric control diet & Hba1c after 3 months	14.496	.000
- Caloric control diet & Hba1c after 6 months	2.698	.029
- Plant based diet & Hba1c after 3 months	14.496	.000
- Plant based diet & Hba1c after 6 months	9.951	.006

Significance level ≤ 0.5

Table (4) describes that; there were a statistically significance difference between studied patients' BMI with caloric control diet after 3 and 6 months while there were no statistical significance difference between BMI and ketogenic or plant based diet after 3 and 6 months.

Table 4: Correlation between type of diet & BMI after 3 months and 6 months among the studied patients (n = 90).

Item	r	Sign.
- Type of diet & BMI after 3 months	4.279	.639
- Type of diet & BMI after 6months	10.679	.099
- Ketogenic diet & BMI after 3 months	5.408	.067
- Ketogenic diet & BMI after 3 months	2.650	.266
- Caloric control diet & BMI after 3 months	21.865	.001
- Caloric control diet & BMI after 6 months	18.520	.005
- Plant based control diet & BMI after 3 months	11.791	.067
- Plant based diet & BMI after 6 months	6.982	.137

Significance level ≤ 0.5

Table (5) illustrates that; there were statistically significance differences in sleep disturbance with caloric control and plant based diet only after 6 months while there were no statistical significance differences between sleep disturbance and ketogenic diet.

Table 5: Correlation between type of diet & sleep disturbance after 3 months and 6 months among the studied patients (n = 90).

Item	r.	Sign.
- Type of diet & sleep disturbance after 3 months	9.989	.007
- Type of diet & sleep disturbance after 3 months	2.199	.333
- Ketogenic diet & sleep disturbance after 3 months	2.67	.141
- Ketogenic diet & sleep disturbance after 6 months	1.930	.239
- Caloric diet & sleep disturbance after 3 months	5.000	.083
- Caloric diet & sleep disturbance after 6 months	6.097	.002
- Plant base diet & sleep disturbance after 3 months	.007	.716
- Plant base diet & sleep disturbance after 6 months	8.342	.004

Significance level ≤ 0.5

Table (6) describes that; there were statistically significance differences in decrease energy with caloric control diet after 3 and 6 months while there were no statistical significance differences between decrease energy with ketogenic or plant based diet.

Table 6: Correlation between type of diet & decrease energy after 3 months and 6 months among the studied patients (n = 90).

Item	r.	Sign.
- Type of diet & decrease energy after 3 months	7.500	.24
- Type of diet & decrease energy after 6 months	11.554	.003
- Ketogenic diet & decrease energy after 3 months	1.875	.169
- Ketogenic diet & decrease energy after 6 months	938	.306
- Caloric diet & decrease energy after 3 months	7.041	.048
- Caloric diet & decrease energy after 6 months	6.097	.002
- Plant base diet & decrease energy after 3 months	2.172	.156
- Plant base diet & decrease energy after 6 months	2.802	179

Significance level ≤ 0.5

Table (7) describes that; there were statistically significance difference in problems in walking with caloric control diet after 6 months and plant based diet after 3 and 6 months while there were no statistical significance differences between problems in walking with ketogenic diet.

Table 7: Correlation between type of diet & problems in walking after 3 months and 6 months among the studied patients (n = 90).

Item	r.	Sign.
- Type of diet & problems in walking after 3 months	938	.67
- Type of diet & problems in walking after 3 months	3.199	.031
- Ketogenic diet & problems in walking after 3 months	2.67	.141
- Ketogenic diet & problems in walking after 6 months	6.098	.563
- Caloric diet & problems in walking after 3 months	7.041	.83
- Caloric diet & problems in walking after 6 months	9.097	.04
- Plant base diet & problems in walking after 3 months	7.232	.009
- Plant base diet & problems in walking after 6 months	8.342	.004

Significance level ≤ 0.5

Table (8) demonstrates that; there were statistically significance differences in wound healing with caloric control diet after 6 months and plant based diet after 3 and 6 months while there were no statistical significance differences between wound healing with ketogenic diet.

Table 8: Correlation between type of diet & wound healing after 3 months and 6 months among the studied patients (n = 90).

Item	r	Sign.
- Type of diet & delayed wound healing after 3 months	38.200	.370
- Type of diet & delayed wound healing after 6months	60.100	.024
- Ketogenic diet & delayed wound healing after 3 months	7.411	.097
- Ketogenic diet & delayed wound healing after 6 months	7.186	.000
- Caloric control diet & delayed wound healing after 3 months	14.496	.073
- Caloric control diet & delayed wound healing after 6 months	6.097	.025
- Plant based diet & wound healing 3months	2.698	.029
- Plant based diet & wound healing after 6 months	9.951	.006

Significance level ≤ 0.5

Table (9) demonstrates that; there were no statistical significance differences in type of diet with fatigue level, polyuria, problems in work, tingling, blurred vision, problems in social life and swelling after 3 or 6 months among the studied patients.

Table 9: Correlation between type of diet & different studied patients variables after 3 months and 6 months (n = 90).

Item	r	Sign.
- Type of diet & fatigue level after 3 months	112.525	.000
- Type of diet & fatigue level after 6 months	90.000	.000
- Type of diet & polyuria after 3 months	12.194	.000
- Type of diet & polyuria after 6months	71.099	.000
- Type of diet & problems in work after 3 months	1.518	.468
- Type of diet & problems in work after 6 months	3.600	.165
- Type of diet & tingling after 3 months	2.535	.282
- Type of diet & tingling after 6 months	1.098	.578
- Type of diet & blurred vision after 3 months	25.109	.000
- Type of diet & blurred vision after 6 months	3.499	.128
- Type of diet & problems in social life after 3 months	4.984	.83
-Type of diet & problems in social life after 6 months	1.518	.483
- Type of diet & swelling in limbs after 3 months	2.963	.227
- Type of diet & swelling in limbs after 6 months	4.098	.128
- Type of diet & pain in limbs after 3 months	8.38	.606
- Type of diet & pain in limbs after 6 months	6.981	.562

Significance level ≤ 0.5

5. DISCUSSION

Umphonsathien , 2019 reviewed Several studies have shown that improvement in glycemic control in patients with type 2 DM can be achieved by caloric restriction using a very-low-calorie diet (VLCD; Baker, Jerums, & Proietto, 2009). The current research emphasize that results as following any of the three diets under study showed improvement in glycemic control with much better results with the caloric diet form.

(Capstick et al., **1997**; Henry & Gumbiner, **1991**; Lean et al., **2018**; Malandrucco et al., **2012**; Wing et al., **1994**). In patients with severe obesity (body mass index [BMI] ~30 kg/m^2), an improvement in hepatic insulin sensitivity was quickly observed only after a week after VLCD, whereas beta cell defect in insulin secretion was restored later at 8 weeks (Lim et al., **2011**). In patients with extreme obesity (BMI ~45 kg/m^2), however, only an improvement in insulin secretion was observed with no changes in hepatic insulin sensitivity (Malandrucco et al., **2012**). The rate of diabetes remission appeared to be higher among those who lost more weight (Steven, Lim, & Taylor, **2013**).

Julibert, et al. (2019) emphasized that Replacement of 5% dietary energy from carbohydrates, SFA, or MUFA with PUFA also showed beneficial effects on insulin secretion ability. Therefore, the modification of an individual dietary pattern to regularly include foods rich in MUFA and PUFA, such as the MedDiet, can benefit individuals with MetS and hyperglycemia or TD2M

Large cohort studies demonstrate that the prevalence and incidence of type 2 diabetes are significantly lower among those following plant-based eating patterns compared with omnivores and even semi-vegetarians. Those following plant-based diets tend to have lower body mass indices,[13] which protects against type 2 diabetes. Nevertheless, differences in diabetes risk persist despite adjustments for adiposity. J Geriatr Cardiol. 2017

6. CONCLUSION

Dietary choices are a key element of insulin resistance and glaycemic control. Lifestyle changes, particularly diet, can be highly effective in preventing, treating, and even reversing type 2 diabetes. Results of the current study revealed that there were statistically significance difference between studied patients' Hba1c with caloric control and plant based diet only after 6 months and there were no statistical significance difference between Hba1c and ketogenic diet after 3 or 6 months.

Continued research to investigate any benefit of such nutrients in this manner would be greatly beneficial in further understanding the underlying mechanisms of HFD-induced/obesity-associated metabolic impairments and more importantly, combat such disturbances to potentially protect normal/healthy intestine function. Nonetheless, to support intestinal and overall health it is recommended to consume a diet low in fat and high in foods such as bran cereal fiber, vegetables, fruits and tea

7. RECOMMENDATION

- Patients should be alerted as early as possible about role of diet to control diabetes.
- Patients should adhere to dietary regimen proper for their condition.
- Nurses should be encouraged to collaborate with nutritionist to provide different dietary options to the patients.
- Replication of the study on a larger sample and on different geographical settings to allow generalization of findings.

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