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The Effect of Lifestyle Modification for Type 2 Diabetic Patients on the Control of Glycemic Level

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Abstract: **Type 2 Diabetes mellitus, as one of the major universal public health disorders widespread, requires patients' lifestyle modulation which would be conducive in dominating blood glucose. The aim of the study: to evaluate the effect of lifestyle modification on glycemic control of type 2 diabetic patients at Suez Canal University Hospitals at Ismailia city. Subjects & methods: This study was carried out at the Family Medicine Outpatient Clinic and the Diabetic Outpatient Clinic of Suez Canal University Hospitals at Ismailia city in Egypt. A quasi-experimental design made up of a control group and a study group with pre- and post-test administration was applied. 92 type 2 diabetic patients were included in this study. Health promoting lifestyle profile II Scale and Physical assessment sheet were used for data collection in the two groups. Results: After implementing of the program, those patients who received lifestyle modification intervention achieved better health promoting lifestyle domains values and glycated hemoglobin, compared with the control group. Factors related to lower glycated hemoglobin in the present study were lower fasting blood sugar level and increasing physical activity. Conclusion: Overall, lifestyle modification program has a positive influence on blood glucose control of patients with type 2 diabetes mellitus. Therefore, it is recommended to that lifestyle modification interventions should be integral part of the curative management of type 2 diabetic patients, and further study in other places to investigate the effect of lifestyle modification on glycemic control of the patients.**

Keywords: **"lifestyle modification", "type 2 diabetes mellitus", "glycemic control".**

1. INTRODUCTION

Diabetes Mellitus is one of the widespread and universal health problems that affect many people worldwide and in Egypt as well. It is defined as a metabolic disorder caused by different factors, which is characterized by elevated blood glucose level (hyperglycemia) and is usually associated with metabolism abnormalities of carbohydrates, fats and proteins **(Sami *et al.*, 2017).** Type 2 Diabetes Mellitus (T2DM) is the most common form of diabetes, constituting nearly 90% of the diabetic patients in any country with a significant increase in the Middle East Region. In Egypt, there were 8.222.600 cases of diabetes among adults in 2017 and this is subjected to rise to 16.7 million cases by 2045. The International Diabetes Federation has ranked Egypt as number eight out of the top ten countries in prevalence of diabetes

(International Diabetes Federation (IDF), 2017). The spread of T2DM is increasing all over the world, probably due to the expectations of population's long life, a sedentary lifestyle and above all, the increasing rates of obesity **(Pisimisis, 2013).**

Lifestyle is an individual's typical way of life, whether healthy or unhealthy, which includes activities and attitudes that influence man's health. However, a healthy lifestyle often results in better health and happiness. In contrast, an unhealthy lifestyle may cause illness and morbidity. Lifestyle related risk factors are associated with the development and progression of T2DM. These risk factors such as inactive lifestyle, smoking, alcohol drinking, dietary choices and overweight are undoubtedly modifiable. The cornerstone of T2DM management includes appropriate lifestyle choices supported by regular medication and blood glucose self-monitoring, where necessary **(Wu *et al.*, 2014; Gheibizadeh *et al.*, 2017).**

A recent study proved that the uncontrolled diabetes, predominantly with elevated blood sugar over a prolonged period of time would lead to a number of short and long-term health complications **(Ahmed *et al.*, 2018).** The core of controlling T2DM depends mainly on physical activity and nutrition regimen. The recent studies have proved the benefits of physical activity on individuals who maintain a physically active lifestyle and therefore, they are less likely to develop T2DM. On the same line, healthy nutrition is the basis for the treatment of T2DM. It positively maintains blood glucose to be within normal limits and effectively minimizes the complications of the T2DM. Weight loss is also an important goal because it enhances glycemic management **(Mohamed, 2014; American Diabetes Association (ADA), 2018).**

The community health nurse had an effective role in patient education about all newly lifestyle modification for T2DM. In diabetes Mellitus care, lifestyle modification can prevent or delay the complications and decrease the need for medication. Encouraging and supporting lifestyle modifications could help in enabling Type 2 diabetic patientsto feeling more satisfied in controlling of their disease **(Chenary *et al.*, 2015).** For chronic illnesses where there is no cure, it is important to establish that therapy which really makes people feel better.

The aim of the study:

The aim of this study was to evaluate the effect of lifestyle modification on glycemic control of type 2 diabetic patients at Suez Canal University Hospitals at Ismailia city.

Study hypothesis:

The lifestyle modification intervention will have a positive effect on blood glucose control of patients with type 2 diabetes mellitus.

2. SUBJECTS AND METHODS

Research design:

A quasi-experimental design was used in conducting the study to evaluate the effect of lifestyle modification on glycemic control of type 2 diabetic patients.

Research setting:

The study was conducted at the Family Medicine Outpatient Clinic and the Diabetic Outpatient Clinic of Suez Canal University Hospitals, which are considered teaching referral tertiary hospitals at Ismailia city in Egypt. These clinics provide research, preventive and curative services according to the patients' condition on a monthly basis.

Target population:

The subjects eligible for the designed study included all type 2 diabetic patients in the study setting during the period of the study who were fulfilling the following criteria:

- Inclusion criteria: -

- Newly diagnosed type 2 diabetic patients, ≤ 5 years.

- Aged 30 years or older.

- Treated with diet regime and /or oral hypoglycemic agents only.

- Accepted to participate in the study.

- Exclusion criteria: -

- People with type 1 diabetes mellitus or gestational diabetes.

- Had a history of psychiatric disorders.

- Attended to previous diabetes education.

Sample size calculation:

A purposive sample consisted of 92 type 2 diabetic patients fulfilled the previous criteria in the setting and a random allocation of the participants into approximately equal two groups was done using the random number table. The sample size was calculated according to **Wassertheil-Smoller, (2004)** as the following equation:

$$n = \frac{(p_1 q_1) + (p_2 q_2)}{(p_2 - p_1)^2} \times f(alpha, power)$$

Tool (I): Interviewing Questionnaire: Includes two parts: **Part I:** Concerned with socio-demographic data and socio-economic status of the studied sample using socio-economic status scale which developed by **El-Gilany et al., (2012)** which consists of 20 questions with a total score of 84. **Part (II):** Included questions about diabetes history. **Tool (II): Health promoting lifestyle profile II Scale:** Developed by **Walker *et al.*, (1995)** based on Pender's health promotion model to measure health-promoting behaviors. **Abd El-Hameed (2011)** has translated it into Arabic and the researcher modified its content to meet the Egyptian culture. On utilization for this study, which consists of 46 items, the researcher's aim was to measure the healthy lifestyle behaviors as follows: health responsibility (6 items), physical activity (8 items), nutrition (9 items), spiritual growth (6 items), interpersonal relations (9 items) and stress management (8 items) **(Table II).** All the items of the healthy lifestyle behavior scale were of positive presentation, there were no reversed items. It used a 4- point rating scale, ranging from 1 (never), 2 (sometimes), 3 (often), and 4 (routinely), which was attached to each statement..

Scoring system:

A score for overall health-promoting lifestyle was obtained by calculating a weighted-mean of the individual's responses to all 46 items; six domains/subscale scores were obtained similarly by calculating a mean of the responses to subscale items. The use of means rather than sums of scale items was recommended to retain the 1 to 4 metric of item responses and to allow meaningful comparisons of scores across subscales. The resultant 4-scale Likert/provoked trend value was calculated from the weighted mean according to the following criterion: ever ≥ 0.000; sometimes ≥ 1.750; often ≥ 2.500; routinely ≥ 3.250.

Tool (III): Physical assessment sheet: Included Anthropometric measurements like (height, weight, and body mass index), measurement of blood glucose control through glycated hemoglobin (HbA1c) level & fasting plasma glucose level. Expected values of Glycated Hemoglobin were according to **Alramadan *et al.*, (2017)** as follows: Good control (< 7%); fair control (7-8%); Poor control (≥8-9%); and Very poor control (≥9%).

Tools validity and reliability:

It was be ascertained by five expertise of professors and lecturers from community health nursing and medical staff who were reviewed the tools content for clarity, relevance, comprehensiveness, and understandable. To assess reliability of the Health promoting lifestyle profile II Scale, the test–retest Alpha-Cronbach reliability coefficient for the Health promoting lifestyle profile II Scale of all items was 0.85.

Pilot study:

A pilot study was conducted on ten type 2 diabetic patients from the Family Medicine Outpatient Clinic and the Diabetic Outpatient Clinic of Suez Canal University Hospitals to test the tools for its clarity, organization, applicability and to determine the length of time needed to collect the data. They were later excluded from the sample. The purpose of the pilot study was to test the clarity and applicability of the study tools and to determine the time needed to fill out the questionnaire sheet.

Field of work:

The study was implemented through the following four phases: Assessment, planning, implementation, and evaluation. Collection of the data covered a period of seven months from 1st of November 2018 until the end of May 2019.

Phase I: Assessment (Pre-test phase)

This phase was conducted by the researcher during the period from the beginning of November 2018 to the end of January 2019. After preparing the study tools, the studied sample was recruited. The researcher applied the study tools to assess the studied sample' lifestyle pattern and to measure of their fasting plasma glucose level, glycated hemoglobin and body mass index at baseline.

The data collection was done first using the interview questionnaire sheet, after identifying the patients who fulfilled the criteria of the study, the researcher introduced herself to the patients, their consent to be recruited in the study was obtained orally after explaining the aim of the study and the activity took place in the previously mentioned outpatient clinics. During the interview, the researcher read each item/question on a data collection sheet and explained its meaning to the patients. Then the patients were asked to write down their answers (for those patients who couldn't read and write questionnaire form was filled by the researcher) and measuring their fasting plasma glucose level, glycated hemoglobin level and body mass index. Each sheet lasted about 15:30 minutes to be filled depending on the response of the patient. Confidentiality of all collected information was strictly assured.

Phase (II): Program Planning

Based on the information obtained from initial assessment, in addition to literature, and the application of the Pender's health promotion model emphasizes on individual characteristics and experiences (previous behaviors and personal factors); (b) behavior specific cognitions and affects (perception of benefits, barriers, self-efficacy, activity related affect, interpersonal influences, and situational influences); and (c) behavioral outcomes (commitment to the plan of action, and demands and preferences) in each type of questions, the researcher designed the lifestyle modification program under the guidance of the supervisors.

The first step in developing this program was to determine the main aim and objectives. These objectives were derived from the assessed needs of the studied sample. These were categorized into specific objectives and tasks were ordered in sequential order consistent with teaching and learning process. The lifestyle modification program was set in eight Arabic sessions including the following:

- Definition, classification and etiology of diabetes mellitus.
- Definition and signs & symptoms of type 2 diabetes mellitus.
- Treatment regimen for type 2 diabetic patients.
- Complications of diabetes mellitus, hyperglycemia and hypoglycemia.
- Dietary modifications such as main balanced diet, food groups, and meal planning.
- Physical activity such as importance of regular physical activity and kinds of exercise suitable for type 2 diabetic patients.
- Self-monitoring of blood glucose level.
- Self-care (foot care and dental care) for type 2 diabetic patients to achieve the desired glycemic control.

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Teaching methods and materials:

The methods used included lecture, discussion group, demonstration, interactive presentation and brain storming. Media such as power point, pictures educational videos and flipcharts were used. Also, a booklet was developed for the study group which is written in a simple Arabic language with different illustrated color pictures to enhance the learning process and facilitate patients' understanding based on their needs. The same experts who validated the tools also revised and validated the booklet.

Phase (III): Program Implementation

The lifestyle modification program was carried out in waiting area in the Family Medicine Outpatient Clinic and the Diabetic Outpatient Clinic of Suez Canal University Hospitals at Ismailia city. The program consisted of two main parts:

The first part: is the theoretical part, which covered the basic knowledge about diabetes such as definition, classification and etiology, signs & symptoms, treatment regimen, complications, hyperglycemia, hypoglycemia; importance and kinds of suitable physical activity; dietary modification (healthy nutrition); self-monitoring of blood glucose level and self-care for type 2 diabetic patients.

The second part: is the practical part, which included developing a daily balanced nutritional meal; how to walk properly; how to do stretching exercises and scheduling a daily physical activity program.

The studied sample was divided into equal two groups (the study and the control group, 46 patients/ group) and the program was conducted for the study group. The researcher ensured a learning environment that is most convenient to the study group. The time scheduling of educational activities gave considerations to time of sessions that best suit the study group. The study group divided into six small subgroups; each group contained nearly 7-8 patients. At the beginning of the first session, an orientation to the aim of the study and the goals of the program took place. Also, the patients were oriented about the phases of the study and the program sessions (time, duration, place, and contents). The program was conducted through eight sessions (two times per month per group) extending for four months during the period from the beginning of February 2018 to the end of January 2019 (with a single session per time). The researcher stressed on the importance of continuous attendance and active participation. The length of every session was variable considering patients and their conditions, approximately 30:35 minutes. During the classes, patients were inspired to raise queries and receive feedback from them. At the end of each session, presentations were submitted to the patients in the form of handout notes. Before the onset of each session, the contents of the previous session were reviewed in short. The patients were allowed to ask any interpretation, elaboration or explanation of any item included in the sessions. The program was presented in a clear and concise form to be used as memorial reference.

Phase IV: Evaluation (Post-test)

After implementation of the program, evaluation of the program impact was tested. Data were collected concerning lifestyle pattern, fasting plasma glucose, glycated hemoglobin and body mass index immediately after completion of the program using the same tools which were used in the pre-test.

Ethical considerations:

All relevant ethical issues are considered for ensuring patients' privacy and confidentiality of the collected data during the study. The purpose of the study and the importance of intervention in diabetes were explained to each patient, and then an oral consent for participation in the study was obtained from each one of them. Voluntary participation and right to refuse to participate in the study and withdrawn at any time was emphasized to the patients.

3. STATISTICAL DESIGN

The researcher has the collected data organized, categorized, tabulated, processed, and analyzed by the use of Statistical Package for Social Sciences version 22, (SPSS Inc., and Chicago, IL). Descriptive statistics were bestowed as frequency, percentage, weighted mean and standard deviation. Independent t-test, paired t-test, Kendall Tau Correlation, to test statistical significance of some variables and Coefficient multiple linear regressions to test effectiveness of the program. P-value ≤ 0.05 indicates significant results while P-value is highly significant at level of ≤ 0.001

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4. RESULTS

Table (1) revealed that there was highly statistical significant difference in the mean of total score of socio-economic status, overall health-promoting lifestyle score, physical activity domain scores, and spiritual growth domain scores in males than females. Also, there was highly statistical significant difference in the mean of body mass index scores in females than males.

Table (2) showed that there were statistically high significant differences between pre- and post-tests regarding health promoting lifestyle domains in the study group (P-value ≤ 0.001 or P-value ≤ 0.0001). Patients who received lifestyle modification intervention had higher health promoting lifestyle domains values. However, **Table (3)** illustrated that there were statistically significant differences between pre- and post-tests of all domains except that for the physical activity, interpersonal relations domains in the control group.

There were statistically high significant differences between pre- and post-tests regarding clinical data in the study group (P-value ≤ 0.009 or P-value ≤ 0.0001). Patients who received lifestyle modification intervention had lower (i.e. better) clinical data values while there were not any statistical significance between pre- and post-tests regarding clinical data in the control group **Table (4)**.

Table (5) described that there was a statistical significance positive correlation between study-group-pre-test's total score of health promoting lifestyle and their occupational status (r = 0.277; P-value ≤ 0.018). However, in case of the Control-group-pre-test, there was statistical significance negative association between their total score of health promoting lifestyle and gender (r = -0.342; P-value ≤ 0.006), whereas with the following variables; educational level (r = 0.304; P-value ≤ 0.009), occupational status (r = 0.280; P-value ≤ 0.018) and socio-economic level (r = 0.327; P-value ≤ 0.006) were of statistically significance positive correlation. As for the Control-group-post-test, there was statistical significance negative association between their total score of health promoting lifestyle and gender (r = -0.312; P-value ≤ 0.012), while there were statistical significance positive associations between their total score of health promoting lifestyle & the following variables; age (r = 0.251; P-value ≤ 0.037), educational level (r = 0.245; P-value ≤ 0.036), occupational status (r = 0.276; P-value ≤ 0.020) and socio-economic level (r = 0.266; P-value ≤ 0.026). These results of significant association measures have exposed that all the values related to both the Study group and Control group were intermediate.

Table (6) indicated that there were rare statistical significance associations, positive & intermediate, between total score of health promoting lifestyle of the Study-group-pre-test's and both following planned diet regimen (r =0.244; P-value ≤ 0.049) and physical activity (r = 0.275; P-value ≤ 0.027).

Table (7) demonstrated that after implementing the program in the study group, fasting plasma glucose was highly significant positive independent predictor (b= 0.020 ± 0.004; P-value ≤ 0.0001) of glycated hemoglobin (HbA1c), whereas physical activity domain was the only statistical significant negative independent predictor (b= -1.032 ± 0.404; P-value ≤ 0.015) of HbA1c.

5. DISCUSSION

Evidence-based reports have highlighted the significance of informative enlightening and lifestyle modification programs for Type 2 diabetic patientsand conjointly affirmed their role in glycemic control and diminishing diabetes related complications **(do Rosário Pinto *et al.*, 2017).** In fact, engaging in health promotion behaviors was related with a locus of high internal control, perceived self-efficacy and the conviction in one's individual competence to carry out a particular activity and quality of life **(Chilton *et al.*, 2006)** which on the long run, may offer assistance to decrease the national burden of this disease and moving forward the wellbeing for T2DM patients. Subsequently, this study aimed to evaluate the effect of employing a lifestyle modification program on glycemic control of Type 2 diabetic patientsat Suez Canal University Hospitals at Ismailia city.

Health promoting lifestyle domains for the study group pre- and post-tests showed highly statistical significant differences in their knowledge and practice. Those patients who received a lifestyle modification intervention had a higher health promoting lifestyle values, these results agreed with **Mohamed (2014); and Raznahan et al., (2018)** who found that the overall measurements of lifestyle patterns showed significant improvement among their studied sample after participation in lifestyle intervention program. These results also agreed with **Raikar et al., (2017)** who reported that the lifestyle

scores of their studied sample moved forward after intervention (complete health education). The above mentioned discussion and results proved the research hypothesis which illustrates the importance of lifestyle modification on patient knowledge and practice.

The current study also showed that, there were statistically high significant differences between pre- and post-tests regarding clinical findings of fasting plasma glucose (FPG); glycated hemoglobin (HbA1c); and body mass index (BMI) among the study group. Those patients who received lifestyle modification intervention had better clinical information values (i.e. lower HbA1c level; lower FPG level; lower BMI), these results were in agreement with **Castillo et al., (2010)** who found that patients who received the diabetes strengthening instructive program had significantly better clinical results (i.e. diminished levels of weight pick up, glucose levels, and HbA1c levels). Also, **Didarloo et al., (2016)** who studied "Impact of Educational Intervention Based on Interactive Approaches on Beliefs, Behavior, Hemoglobin A1c, and Quality of Life in Diabetic Women" showed that a significant contrast existed between HbA1c levels before and after the intervention in the experimental group.

On the same line, this result was in agreement with **Attridge et al., (2014); Atashzadeh-Shoorideh, et al., (2017)** who found an advancement of glycemic control after the intervention (health education program) within the experimental group. This was proven within the study conducted by **Raikar et al., (2017),** which proved that both way of life and knowledge & practice about DM (self-care practice) were vital parameters to glycemic control. The researcher stressed on the importance of lifestyle modification in improving the diabetic patients' lab tests.

With respect to health promoting lifestyle domains among the control group pre- and post-tests, results outlined that there were statistical significant differences between pre- and post-tests of all domains except that for the physical activity, interpersonal relations domains. Those patients who didn't receive a lifestyle modification intervention had had slight increases (with no trend alter) in their total scores of overall health promoting lifestyle score. This was owing to those patients didn't know how to preserve their healthy lifestyle after being diagnosed with type 2 diabetes mellitus. On the same context, **World Health Organization (2016)** showed that insufficient information about diabetes contrarily influences behavior and self-care practices. From the researcher point of view, acquiring data related diabetes could help patients evaluate their hazard of diabetes, and inspire them to take care of their illness.

Additionally, the results, as anticipated, did not reveal any statistical significance between pre- and post-tests among respect to clinical data (FPG; HbA1c; and BMI) within the control group, these results agreed with **Castillo et al., (2010)** who stated that there were not any statically significant differences between pre- and post-tests with respect to clinical data (FPG; HbA1c; and BMI) among the control group. These study results were steady with those of other studies conducted by **(Attridge et al., 2014; Didarloo et al., 2016; and Atashzadeh_Shoorideh, et al., 2017)** which showed that there was no association between pre- and post-tests with respect to level of glycemic control within the control group. Also, that was consistent with a few studies by **(Khattab et al., 2010; Sazlina et al., 2015; and Ibrahim 2017)** which displayed that poor glycemic control was more frequent in patients who had several unhealthy lifestyle habits. From the researcher point of view, HbA1c score worsened rather than improving during their regular treatment course which reflected some defects within the chain of treatment, low levels of persistent education and lack of access to HbA1c monitoring.

As regards to correlation analysis, the present study revealed that there was a significant positive correlation between study-group-pre-test's total score of health promoting lifestyle and their occupational status, while this significance has been disappeared thereafter. From the researcher point of view, it is expected that availability of knowledge and practice related to health lifestyle behavior differ largely due to diverse occupational/income availability and this influence their unhealthy behavior, but after applying the lifestyle modification program, no critical association could be noted since it appeared that the connected program spurred them to alter their undesirable lifestyle behavior.

Regarding the association between overall health promoting lifestyle and gender, the current study showed that there was highly statistical significance negative association between Control-group-pre-test's total score of health promoting lifestyle and their gender, this high significance has somewhat continued to be in effect with the Control-group-post-test. This result disagreed with **Chilton et al., (2006); Siboni et al., (2018); and Majlesi et al., (2018)** who indicated that gender was not found to be significantly associated with a health-promoting lifestyle, which may reflect a sample contrast.

From the researcher point of view, females' educational level (information) and their socio-economic were not sufficient enough to alter their diabetes management behavior.

Concerning the association between overall health promoting lifestyle and age, the current study displayed that there was highly statistical significance positive correlation between Control-group-post- test's total score of health promoting lifestyle and their age, this significance has developed with the Control-group-post-test. In contrast to, **Chilton et al., (2006)** showed that age was not found to be altogether related with a health-promoting lifestyle. From the researcher point of view, older patients are ready to properly follow the instructions from their care giver and to alter their unhealthy behaviors.

With respect to the association between overall health promoting lifestyle and educational level, the current study revealed that there was highly statistical significant positive relationship between Control-group-pre-test's total score of health promoting lifestyle and their educational level, this significance has proceeded be in impact with the Control-group-post-test. This result disagreed with **Chilton et al., (2006)** who showed that educational level was not found to be essentially related with a health-promoting lifestyle. From the researcher point of view, this disagreement may be due to cultural differences.

As respects to the association between overall health promoting lifestyle and occupational status, the current research revealed that there was statistically significant positive relationship between Control-group-pre-test's total score of health promoting lifestyle and their occupational status, this significance has prolonged to be in impact with the Control-group-post-test. From the researcher point of view, it is expected that availability of resources, knowledge and practice related to health lifestyle behavior differ largely due to diverse occupational/income availability and this influence their unhealthy behavior.

As far to the association between overall health promoting lifestyle and socio-economic level, the present study revealed that there was highly statistical significance positive correlation between Control-group-pre-test's total score of health promoting lifestyle and their socio-economic level, this significance has continued to be in effect with the Control-group-post-test. On the same line, **Chilton et al., (2006)** found that there was significance positive association between higher income and better physical activity therefore, recommended that socioeconomic status may contribute to health-promoting activities of their studied sample.

For the association between glycated hemoglobin (HbA1c) and residence, the current research revealed that there was a significant negative correlation between study-group-post-test's glycated hemoglobin and their residence area, this significance has emerged with the implementation of the program. This agreed with **Othman et al., (2016) and Fiseha et al., (2018)** who detailed that the higher rate of poor glycemic control watched among rural inhabitants. From the researcher point of view, it appeared that urban group showed more devoting to improve their glycemic control; which was perhaps due to their awareness of the risk and bad consequences of poor glycemic control.

Regarding the association between overall health promoting lifestyle and following planned diet regimen, the current study has proved that there was a statistically significant positive relationship between study-group-pre-test's total score of health promoting lifestyle and the planned diet regimen followed, as it were with the study pre-implementation of the program whereas this noteworthiness has been vanished thereafter. From the researcher point of view, since following planned diet regimen is part of the health promoting lifestyle domain, the relation between them are part-of-all relationship.

As for the association between overall health promoting lifestyle and physical activity, this study displayed that there was a significant positive correlation between study-group-pre- test's between overall health promoting lifestyle and performing physical activity, only with the study pre-implementation of the program (i.e. Pre-Test group) while this significance has been disappeared thereafter. From the researcher point of view, since performing physical activity is part of the health promoting lifestyle domain, the relation between them are part-of-all relationship.

As for the association between glycated hemoglobin (HbA1c) and presence of hypoglycemic attacks, the present study showed that the sole statistical significance, negative & intermediate, association was only between Study-group-pre-test's glycated hemoglobin and presence of hypoglycemic attacks (*i.e.* expanded recurrence of hypoglycemic attacks would be related with a lower value of HbA1c). However, this significance has been disappeared thereafter. On contrast to,

Retornaz et al., (2017) who studied "Assessment of glycemic control in nursing home residents with diabetes", and found that there was no association between the hazard of hypoglycemia and HbA1c and they proposed that HbA1c wasn't the satisfactory marker for the detection of hypoglycemia risk.

As regards to glycated hemoglobin multiple linear regressions illustrated that fasting plasma glucose was highly significant positive independent predictor of glycated hemoglobin (HbA1c). This result concurred with **Retornaz et al., (2017)** who found that HbA1c was essentially higher in patients with direct or serious unremitting hyperglycemia. Whereas physical activity domain was the only statistical significant negative independent predictor of HbA1c, the later statistic revealed that performing any physical movement would trigger advancement in glycemic control after utilizing the program within the study group.

Additionally, there's strong proof of the impact of normal exercise on lowering HbA1c for people with T2DM **(Colberg et al., 2010; Church et al., 2010; and Fseha, 2017).** Also, this was in agreement with **Seyyednozadi et al., (2008)** who studied "Role of Physical activity and Nutrition in Controlling Type 2 Diabetes Mellitus", and detailed that the physical activity intervention had a significant impact in diminishing HbA1c.

Moreover, this result agreed with **Avery et al., (2012)** who studied "Changing physical activity behavior in type 2 diabetes: a systematic review and meta-analysis of behavioral interventions", and found that lifestyle interventions which increased physical and exercise activity were associated with improvements in HbA1c. This result concurred too with **Boulé et al., (2001)** who studied "Effect of exercise on glycemic control and body mass in type 2 diabetes mellitus", and emphasized that work out preparing diminishes HbA1c levels by an amount that ought to diminish the hazard of diabetes complications.

This result concurred moreover with **Htoo (2015)** who studied "Is Lifestyle Modification Effective for Glycemic Control among Type II Diabetic Adults in Southeast Asia?", and detailed that physical activity interventions have most significant effect on glycemic control among diet, physical activity and general lifestyle interventions within the Southeast Asia. This might be affirmed by **Park and Lee (2015)** who found that physical activity based on escalated of high-impact work out was found to be altogether related to glycemic control.

In contrast to, the study titled "Physical activity and reported barriers to activity among T2DM diabetic patients in the United Arab Emirates" conducted by **Al-Kaabi et al., (2009),** showed that there was no association between physical activity and glycemic control. This was comparable to the **ADA (2018)** who suggested physical activity to be performed for at least 150 minutes per week with direct concentrated activity together with inclusion of resistance training if not contraindicated. This might be clarified as illustrated in some studies conducted by **the American Diabetes Association, (2013)** which reported that standard physical work out for type 2 diabetes patients enabled them to increase their glucose take-up, with sequential improvement in glycemic control (decrease glycated hemoglobin).

6. CONCLUSION

Based on the findings of the current study, it could be concluded that type 2 diabetic patients who have received lifestyle modification program (dietary modification, physical activity, self-blood glucose monitoring and diabetes self-care education) and attended to the Family Medicine Outpatient Clinic & the Diabetic Outpatient Clinic of Suez Canal University Hospitals at Ismailia city in Egypt has a positive effect on glycemic control (HbA1c) among patients with type 2 diabetes mellitus and also improved their health promoting lifestyle domains post lifestyle modification program

7. RECOMMENDATIONS

According to the results of the present study, the following recommendations could be deduced:

1. Health education about type 2 diabetes mellitus should be provided to all patients attended to diabetic clinics.
2. Teach lifestyle modification to all diabetic patients and its effect on their control of glucose level.
3. Illustrated booklet about diabetes and important of lifestyle modification should be available in all health care setting provided care for diabetic patients.
4. Further researches in other places to detect the effect of health education program about lifestyle on control glucose level among the patients with type 2 diabetes mellitus.

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APPENDICES - A

RESULTS

Table (1): Baseline characteristics of the studied sample (n= 92).

Baseline characteristics	Females (n=63)		Males (n=29)		t-test	p-value
	Mean	SD	Mean	SD		
Age (years)	48.59	8.52	52.31	10.20	1.828	0.071
Total score of socio-economic status	36.98	10.14	50.38	15.27	**4.987**	**0.0001******
Overall health-promoting lifestyle score	2.21	0.24	2.38	0.26	**2.917**	**0.004****
Health Responsibility Domain	2.03	0.49	2.01	0.371	0.254	0.800
Physical Activity Domain	1.25	0.30	1.59	0.39	**4.582**	**0.0001******
Nutrition Domain	2.52	0.28	2.56	0.36	0.598	0.551
Spiritual Growth Domain	2.74	0.39	3.06	0.41	**3.642**	**0.0001******
Interpersonal Relations Domain	2.59	0.48	2.80	0.46	1.967	0.052
Stress Management Domain	2.12	0.36	2.22	0.38	1.130	0.262
Glycated hemoglobin level (HbA1c) (%)	8.26	1.91	7.59	1.47	1.677	0.097
Fasting Plasma Glucose (FPG) (mg/dl)	184.33	82.99	158.86	63.79	1.464	0.147
Body Mass Index (BMI) (kg/m^2)	34.12	5.76	28.70	4.14	**4.543**	**0.0001******
Duration of the previous diagnosis of diabetes (years)	2.47	1.91	2.83	1.72	0.861	0.392

SD: Standard deviation.

Table (2): Testing of the Significance of the Changing situation (coupled with weighted mean& trends) of the study group's health promoting lifestyle domains after lifestyle modification intervention (N=46/ group).

Variables	Pre-test		Post-test		t-test	P-value
	Mean	SD	Mean	SD		
Overall health-promoting lifestyle score	2.27	0.26	2.60	0.30	7.41	0.0001*****
	Sometimes		Often			
Health Responsibility Domain	2.13	0.46	2.47	0.43	4.89	0.0001****
	Sometimes		Sometimes			
Physical Activity Domain	1.40	0.41	1.72	0.49	3.41	0.001***
	Never		Never			

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Nutrition Domain	2.53	0.32	2.96	0.42	7.50	0.0001****
	Often		Often			
Spiritual Growth Domain	2.87	0.43	3.13	0.38	3.74	0.001***
	Often		Often			
Interpersonal Relations Domain	2.59	0.44	2.89	0.38	5.02	0.0001****
	Often		Often			
Stress Management Domain	2.17	0.35	2.48	0.41	5.76	0.0001****
	Sometimes		Sometimes			

SD: Standard deviation.

Table (3): Testing of the Significance of the Changing situation (coupled with weighted mean& trends) of the control group's health promoting lifestyle domains after lifestyle modification intervention (N=46/ group).

Variables	Pre-test		Post-test		t-test	P-value
	Mean	SD	Mean	SD		
Overall health-promoting lifestyle score	2.25	0.26	2.35	0.24	3.82	0.0001****
	Sometimes		Sometimes			
Health Responsibility Domain	1.92	0.43	2.12	0.37	4.11	0.0001****
	Sometimes		Sometimes			
Physical Activity Domain	1.32	0.31	1.31	0.35	0.15	0.881
	Never		Never			
Nutrition Domain	2.54	0.30	2.68	0.31	2.66	0.011*
	Often		Often			
Spiritual Growth Domain	2.82	0.41	2.97	0.37	2.61	0.012*
	Often		Often			
Interpersonal Relations Domain	2.73	0.51	2.78	0.40	0.90	0.372
	Often		Often			
Stress Management Domain	2.14	0.38	2.26	0.38	2.39	0.021*
	Sometimes		Sometimes			

SD: Standard deviation.

Table (4): Testing of the Significance of the Changing situation of the studied sample groups' clinical data after lifestyle modification intervention (N=46/ group).

Variables	Study group				Control group			
	Pre-test		Post-test		Pre-test		Post-test	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Glycated hemoglobin (HbA1c) (%)	7.78	1.77	6.64	1.22	8.31	1.82	8.51	1.60
t-test (Sig.)	**6.64 (0.0001)******				0.98 (0.332)			
Fasting Plasma Glucose (mg/dl)	173.83	81.22	124.74	37.72	178.78	75.49	168.74	46.70
t-test (Sig.)	**4.42 (0.0001)****				0.90 (0.371)			
Body Mass Index (Kg/m^2)	33.32	6.47	32.66	5.94	31.50	5.07	31.16	4.53
t-test (Sig.)	**2.75 (0.009)****				0.96 (0.344)			

SD: Standard deviation.

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Table (5): Correlation between Pre- and Post-tests' total score of health promoting lifestyle and socio-demographic characteristics for the study and control groups [N=46/ group].

Socio-demographic characteristics		Total score of health promoting lifestyle			
		Study group		Control group	
		Pre-test	Post-test	Pre-test	Post-test
Gender	r	-0.173	0.198	-0.342**	-0.312*
	Sig.	0.164	0.110	0.006	0.012
Age groups (years)	r	0.113	-0.119	0.100	0.251*
	Sig.	0.362	0.339	0.403	0.037
Marital status	r	0.024	0.114	-0.061	0.032
	Sig.	0.846	0.350	0.619	0.793
Educational level	r	0.203	0.053	0.304**	0.245*
	Sig.	0.076	0.641	0.009	0.036
Occupational status	r	0.277*	-0.068	0.280*	0.276*
	Sig.	0.018	0.559	0.018	0.020
Residence	r	0.129	0.070	0.231	0.224
	Sig.	0.299	0.573	0.063	0.072
Type of family	r	-0.179	0.055	0.063	-0.026
	Sig.	0.150	0.660	0.614	0.833
Socio-economic level	r	0.218	0.072	0.327**	0.266*
	Sig.	0.070	0.548	0.006	0.026

r = Kendall Tau Correlation Coefficient.

Table (6): Correlation between Pre- and Post-tests of the total score of health promoting lifestyle and Diabetes history data for the study and the control groups [N=46/ group].

Diabetes history data		Total score of health promoting lifestyle			
		Study group		Control group	
		Pre-test	Post-test	Pre-test	Post-test
Duration of the previous diagnosis of diabetes (years)	r	0.000	-0.057	0.031	0.004
	Sig.	1.000	0.643	0.802	0.973
Family history of diabetes	r	-0.125	-0.122	-0.032	0.114
	Sig.	0.313	0.324	0.797	0.360
Presence of diabetes related complications	r	-0.106	0.049	-0.188	-0.089
	Sig.	0.372	0.682	0.117	0.455
Presence of comorbid diseases	r	0.172	0.088	0.188	0.109
	Sig.	0.166	0.478	0.130	0.383
Presence of hypoglycemic attacks	r	-0.044	-0.061	0.070	0.120
	Sig.	0.710	0.606	0.557	0.313
Treatment regimen	r	-0.084	0.080	-0.030	0.114
	Sig.	0.455	0.474	0.786	0.304

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Medication adherence	**r**	**0.048**	**-0.141**	**-0.094**	**-0.219**
	Sig.	**0.698**	**0.256**	**0.449**	**0.078**
Glucose monitoring regularity	**r**	**0.137**	**0.160**	**0.133**	**0.147**
	Sig.	**0.270**	**0.197**	**0.286**	**0.239**
Following planned diet regimen	**r**	**0.244***	**0.094**	**0.067**	**0.064**
	Sig.	**0.049**	**0.450**	**0.593**	**0.608**
Physical activity regularity	**r**	**0.275***	**0.150**	**0.228**	**0.183**
	Sig.	**0.027**	**0.225**	**0.067**	**0.143**

r = Kendall Tau Correlation Coefficient.

Table (7): Multiple linear regressions coefficient for the predictors of Glycemic control (Glycated hemoglobin value; HbA1c) in the study group after lifestyle modification intervention (N=46).

Variables	**Glycemic control value (HbA1c)**				
	Unstandardized Coefficients		**Standardized Coefficients**	**t-test**	**P-value**
	B	**Std. Error**	**Beta**		
(Constant)	7.976	1.980		4.03	0.0001****
Fasting Plasma Glucose (mg/dl)	0.020	0.004	0.613	4.53	0.0001****
Health Responsibility Domain	-0.761	0.440	-0.267	-1.73	0.092
Physical Activity Domain	-1.032	0.404	-0.412	-2.56	0.015*
Nutrition Domain	0.562	0.500	0.194	1.12	0.268
Spiritual Growth Domain	0.556	0.599	0.173	0.93	0.359
Interpersonal Relations Domain	-0.591	0.581	-0.183	-1.02	0.316
Stress Management Domain	0.194	0.462	0.065	0.42	0.678
Duration of the previous diagnosis of diabetes	-0.122	0.093	-0.191	-1.32	0.196