

Diabetes Mellitus Risk Reduction among Pre-diabetics: Sustained Integrated Theory Based Nursing Intervention

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ABSTRACT

Background: Diabetes mellitus is a global health problem causing premature death rather than individuals, families and societies economic burden. **Aim:** To determine the effect of protection motivation sustained integrated nursing intervention on type 2 diabetes mellitus risk among pre-diabetics. **Subjects & Methods:** Purposive sample of 250 pre diabetics matched to the inclusion criteria was selected. **Setting:** General medical department and diabetic out-patients' clinics at Menoufia University and Shebien El-kom Teaching hospitals. **Tools:** Four tools were utilized. I. Self-administered questionnaire II: Protection Motivation Theory questionnaire; III: Nutritional assessment sheet. IV: Diabetes mellitus modifiable risk assessment score. **Design:** A quasi-experimental with pre, posttest and follow up was utilized. **Results:** The mean age of studied pre-diabetics was 44 years, the percentage of good dietary health habits was improved from 18.4% in pre intervention to 39.6% in post intervention and reached to 51.6% in follow up. High statistically significant activity level improvement from 25.2% pre intervention to 42.4% post intervention with $p < 0.0001$. Statistically significant reduction in cumulative blood glucose level among pre-diabetics in post intervention and follow up from 46% and 23 % respectively. Percentage of regular checkup of blood glucose increased from 2.4% to 39.6% then to 55.6% from pre to post then to follow up, respectively. Percentage of low risk pre-diabetics increased from 24% to 59.6% in post intervention and reached to 84% in follow up intervention with P value < 0.001 . **Conclusions:** The protection motivation sustained integrated nursing intervention had been beneficial in decreasing total risk score of Diabetes mellitus among pre-diabetics, improving the disease related healthy behavior as consuming a healthy diet, being physically active, reducing their weight, cholesterol & cumulative glucose level and number of smoked cigarettes. **Recommendation:** Close monitoring, early detection and proper management of pre-diabetics should be carried out by each country-authorized personnel.

Key words: Diabetes mellitus risk reduction, Pre-diabetics, Theory based nursing intervention.

Introduction

Type 2 diabetes mellitus (T2DM) remains a fast-growing public health problem especially in low-income countries, including African countries with a significant impact on morbidity, mortality and health care resources. Egypt has been identified as the ninth leading country in the world for the number of patients with T2DM. The prevalence of T2DM in Egypt was almost tripled over the last two decades. Currently, it is around 15.6% of all adults aged 20 to 79 years⁽¹⁾.

Diabetes mellitus usually associated with a two- to four-folds increased risk of developing

cardiovascular and micro-vascular complications, which may already be present before diagnosis.

Therefore, it is important to detect pre-diabetic patients at an early stage. Pre-diabetics are people in the intermediate stage between normal glucose tolerance and overt T2DM; they recently defined through HbA1c which referring to the individual's average blood sugar over the previous two to three months⁽²⁾.

Fortunately, the disease related modifiable risk factors as overweight/obesity, physical inactivity, hypercholesterolemia, hypertension, tobacco and alcohol use and excessive uncontrolled stress can

be changed by treatment, intervention, or behavioral and life style changes. Healthy lifestyle, not using tobacco, being physically active, maintaining a healthy weight and making healthy food choices greatly reduce person's risk of developing DM⁽³⁾.

Nursing educational interventions are the main base for all preventive measures. As a result, past researches have highlighted the importance of nurse education in improving screening practices. Comprehensive, integrated and sustained educational interventions are clearly needed in order to increase awareness for decreasing DM risk among pre-diabetic patients with modifiable risk factors. Studies show that theory-based nursing intervention that applies cognitive frameworks had been positively affecting results⁽⁴⁾.

T2DM can be prevented or even delayed for a few years by managing the modifiable risk factors which will benefit health. So, pre-diabetic patients with modifiable risk factors should be taught to modify their life style through consuming healthy diet, manage their stress, getting enough sleeping hours, being physically active most days of the week, losing weight gradually to achieve a healthy body mass index, monitor the predisposing health problems as hypercholesterolemia⁽⁵⁾.

The selection of a relevant and influential theory-based intervention for behavioral change is the first stage in building an effective educational nursing program. Rogers (1975) introduced the protection motivation theory (PMT), which is now widely regarded as a broad paradigm for predicting health behaviors and health-related interventions. It is a social cognition theory that is used to assess protective behavior and variables that influence motivations. Fear, according to Rogers, may boost positive protective motives by enhancing eight elements: perceived vulnerability, perceived severity, perceived reward, self-efficacy, response efficacy, response cost, and fear and protection motivation⁽⁶⁾.

The theory is designed to explain the effective and ineffective adaptive behaviors at the time of feeling threatened with health status. Based on this Theory, two types of threat appraisal and coping appraisal determine the intent of individuals for protective behaviors. Threat estimation involves understanding severity and

perceived sensitivity of disease. The third factor added is the reward which is the consequence of selecting a good healthy behavior; therefore the coping appraisal is based on self - efficacy, response efficacy and cost of response. In general, based on this theory, if individuals feel more threatened regarding the consequences of not performing a behavior and, at the same time, adapt to this threat, there is a motive for changing behavior⁽⁷⁾.

2- Significance of study

In Egypt, Global diabetes prevalence was anticipated at 9.3% (463 million people) in 2019, rising to 10.2% (578 million) by 2030 and 10.9 percent (700 million) by 2045. Urban regions (10.8 percent) have a greater frequency than rural areas (7.2 percent), while high-income nations (10.4 percent) have a higher incidence than low-income countries (4.0 percent). One-half of persons with diabetes (50.1%) are unaware that they have the disease. Impaired glucose tolerance is anticipated to affect 7.5 percent (374 million) of the world population in 2019, rising to 8.0 percent (454 million) by 2030 and 8.6 percent (548 million) by 2045⁽⁸⁾.

Pre-diabetics remain undiagnosed as a result of lack of screening and inadequate diagnostic facilities. On the other hand, patients who already have T2DM suffering from severe complications due to lack of self-care awareness, financial resources, regular checkup and facilities for medical supervision. Because the prevention is better than cure, measures should be taken to decrease diabetes mellitus risk among pre-diabetic patients^(9 & 10).

Although, the protection motivation theory has been used in several studies associated with adoption of healthy behaviors, limited studies have focused on the adoption of health behaviors in T2DM high risk pre-diabetics. Therefore, this study aimed to determine the effect of protection motivation sustained integrated nursing intervention on T2DM risk among pre-diabetics.

3-Aim of the study

To determine the effect of protection motivation sustained integrated nursing intervention on type 2 diabetes mellitus risk among pre-diabetics.

Research hypotheses

1. Diabetes mellitus related dietary habits and physical activity level among studied sample will be improved post application of protection

motivation sustained integrated nursing intervention.

2. Diabetes mellitus related screening behaviors among studied sample will be regularly performed post application of protection motivation sustained integrated nursing intervention.

3. Diabetes mellitus total risk score will be decreased among studied sample post application of protection motivation sustained integrated nursing intervention.

Subjects and Methods

Design: Quasi-experimental design with pre, posttest and follow up.

Setting: General medical department and diabetic out-patients' clinics of Menoufia University and Shebien El- kom teaching hospitals.

Subjects: A purposive sample of 250 pre-diabetics matched the inclusion criteria was selected based on power of 80 %. The required sample size was determined using Epi info software.

Inclusion criteria

- Pre-diabetics (result of HbA1c analysis pre-intervention ranging from 5.7 to 6.4) having other DM modifiable risk factors.
- Both sexes, comply with follow-up appointment
- Patient's first degree relative admitted with them as an escort especially during intervention period.
- Able to cooperate and communicate
- Free from psychiatric problem.

Exclusion criteria

- 1- Contraindication to physical exercise or handicap.
- 2- Already diagnosed as diabetic.
- 3- Pregnant
- 4- Taking medications (e.g. glucocorticoid therapy, hypothyroidism and Cushing's disease).
- 5- Having metabolic or endocrine disorders.
- 6- Follow weight reduction program (medications /diet) to prevent conflict with the current intervention.

Tools: Four tools were utilized for data collection.

Tool I: Self-administered questionnaire: It was developed by the researcher after extensive reviewing of recent related literature to identify the participants' socio-demographic and their health related practice. It is comprised of three parts.

Part one: Demographic data: including age, sex, marital status, education, occupation, residence, nature of work, income status, self-reported personality nature and telephone number.

Part two: Diabetes mellitus related health practice: including five sections

Section one: Dietary practice: This includes eight questions regarding sugar intake, salts intake, omission of diet, whole grain products, fats intake, fibers intake, number of meals per day, and snacks between meals.

Scoring system: It is measured by three-point Likert's scale (always (zero point), sometimes (one point) and never (two point)). Answers were computed to obtain total mean scores to categorized as good practice with low-risk if the score 0-5 or accepted practice with moderate risk if the score 6-10 and bad practice with high-risk if the score 11-16.

Section two: Physical activity practice: which include four questions: exercise daily at least 30 minutes with moderate or vigorous intensity, increase physical activity and physical effort in everyday life (e.g. walking instead of driving or taking a bus, climbing stairs instead of using elevators, practice active life style, reduce time spent on TV

Scoring system: It is measured by three-point Likert scale (always (zero point), sometimes (one point) and never (two point)). Answers were computed to obtain total mean scores to categorized as bad practice with high-risk if the score 6-8 or accepted practice with moderate-risk if the score 3-5 and good practice with low-risk if the score 0-2.

Section three: Smoking habits: Including a question about smoking habit. Scoring system was 2 for always (high risk), 1 for sometimes (moderate risk) and 0 for never (low risk). Answers were computed to obtain total mean scores

Section four: Checking blood glucose level: Including a question regarding checking blood glucose level. Scoring system was 0 for always (low risk), 1 for sometimes (moderate risk) and 2 for never (high risk). Answers were computed to obtain total mean scores.

Section five: Checking blood pressure: Including a question regarding checking blood pressure. Scoring system was 0 for always (low risk), 1 for sometimes (moderate risk) and 2 for never (high risk). Answers were computed to obtain total mean scores.

Tool II: Protection Motivation Theory questionnaire: Adopted from Jacob 2013⁽¹¹⁾ to evaluate the effect of the protection motivation-based intervention on pre-diabetics. It includes 56 items under 8 major constructs: perceived vulnerability (8

items), perceived severity (8 items), perceived reward (10 items), self-efficacy (10 items), response efficacy (8 items), and response cost (6 items), fear (4 items) and protection motivation (2 items). All items were rated on a 3-point scale ranging from 0 (disagree) and 1 (neutral) to 2 (agree). Answers were computed to obtain total mean scores to categorize each construct as increased or decreased.

Tool III: Nutritional Assessment Sheet: Adopted from **National Nutrient Database for Standard Reference (2000)** ⁽¹²⁾ to evaluate the nutritional status of the participants and it was consisted of three parts.

Part one: Dietary recall tool: Used to calculate total calories consumed by recalling the nutritional elements of the 24 hours of dietary intake for three consecutive days.

Part two: Anthropometric Measurement: Measuring waist circumference and calculate the body mass index by measuring weight and height. BMI which classified according to WHO, 2021 ⁽¹³⁾ as 18.5- 24.9 indicating normal weight with low risk, ≥ 25.00 was overweight with moderate risk and ≥ 30.00 was obese with high risk score.

Part three: Lab investigation: It concerned with the investigation of

- Cholesterol level (scoring 0 with low risk for normal range, 1 with moderate risk if elevated but controlled and 2 with high risk if elevated and uncontrolled).
- HbA1c. Investigated firstly pre intervention to include the person in the study, and then post intervention by three and six months to determine the effect of the study.

Tool IV: Diabetes mellitus modifiable risk assessment score: Adapted from **Bang et al., 2009** ⁽¹⁴⁾ to assess DM modifiable risk score. It included six risks as smoking, cholesterol level, dietary practice, hypertension, body mass index and physical activity practice. The total score of this score was 12.

Scoring system: It is measured by three-point Likert scale. Answers were computed to obtain total mean scores to categorized as 9-12 high risk score or 4-8 moderate risk score and 0-3 low risk score.

Validity and Reliability

All tools were tested for its content validity by experts in the field of Medical Surgical and family and community health nursing. They were asked to judge the items for completeness and clarity. Suggestions were incorporated into the

instrument. All recommended modifications were performed. Test-retest was used to ascertain **reliability** of the developed tools. The reliability of tool one reported that Cronbach's alpha reliability was 0.90. Tool two and tool three was coefficient alpha reliability of 0.92, and tool four was Cronbach's alpha reliability of 0.94 which indicates an accepted reliability of the tool.

Pilot study: It was conducted on 10% of participants to test the clarity and the applicability of the developed tools. The necessary modifications were done accordingly. Data obtained from those participants were not included in the final study.

Data collection procedure

- An official permission from Faculty of Nursing, Menoufia University and directors of the selected settings was obtained for carrying-out the study. Verbal consent was obtained from participants who fulfill the inclusion criteria after explanation the purpose and the nature of the study and its importance. Participants were reassured that any information obtained would be confidential and used only for the study purpose. The researchers emphasized that participation in the study is entirely voluntary and anonymity of the participants were assured through coding data.

- From January 2021 to the end of December 2021, the data were collected by the researchers to have base line data about demographic data, health related practice (diet, exercise and smoking) nutritional assessment sheet which include dietary recall tool and physical examination was performed including anthropometric measurements of body weight was measured with a high-precision scale, with the light clothes and bare foot, and height was measured to the nearest centimeter in the standing position on a Holtain portable anthropometer. The BMI is computed by dividing the weight in kilograms by the square of the height in meters. Waist circumference was measured midway between the lowest rib and the iliac crest. A blood sample was taken from the antecubital vein with the participants in a seated position after an overnight fast, and analyzed in the Biomedicine Laboratory of the hospital to assess cumulative blood glucose and total cholesterol. The collection of base line data took about two days per week for one month in each place, each interview took

about 25-35 minutes from each participant according to their level of understanding.

- Structured nursing intervention was carried out for participants in diabetic outpatient clinics through oral instructions as a method of teaching supported with booklet containing all the information and skills related to prevention of DM were used to introduce the theoretical part of nursing intervention depends on eight main constructs. Through five face-to-face teaching sessions one session per week in each sitting contain about 20 to 30 participants and each one took about 30 to 45 minutes then followed by 10 minutes at the end of each session the researchers made quick revision for receiving information and giving the freedom for participants to ask any questions.

First session: Focused to increase the perceived vulnerability to the threat (development of DM) this session started with a report on the statistics of DM around the world in the region (Middle East), in the country (Egypt) and risk factors. Participants' maladaptive practices regarding lack of vulnerability to DM were discussed.

Second session: Focused on perceived severity of the threat. A documentary videos describing complications and negative outcomes related to poor health habits affecting DM was presented. Participants informed about the negative aspects of DM will occur on their lives.

Third session: Focused on perceived rewards or benefits of prevention and early detection of DM. Emphasized the perceived benefits of preventive behaviors and a healthy lifestyle. Using a focus group discussion format, researchers allow participants to share their viewpoints about healthy behaviors related belonging DM prevention.

Fourth session: Focused on perceived effectiveness of the recommended preventative behavior to increase response efficacy and perceived self-efficacy to perform the recommended practice. To enhance self-efficacy, role model presented lectures to the group on personal lifestyle planning and then took questions from the group.

Fifth session: Focused on protective measures designed to implement structured nursing intervention. Cover the following main items dietary modifications by cutting 500 Kcal, eating three meals per day regularly, no dining out. The

allowed and prohibited food was explained to them. As well as measures to control of high cholesterol level, exercise modification by practice 30 minute a day (approximately 6,000 steps/ day) stretching twice a day and stress management approach . Participants taught how to find better ways to cope with stressors and smoking cessation measures, monitoring hypertension, hypercholesterolemia, and the importance of compliance with regular periodical checkup.

- Each session followed by a summary of essential points then in the last session, the researchers summarized all components of previous sessions.

- Telephone number of each participant was taken to create telephone contact to assess them continuously to be sure that they follow the structured nursing intervention as illustrated by the researcher. Also, what's app group was made for any explanation about nursing intervention and reminding them about time of post assessment and follow up.

-Each participant was evaluated via scheduling meeting with them at the same day for his/her follow up appointment. Evaluation included anthropometric measurements; health related practice, nutritional assessment, protection motivation theory construct and laboratory investigation were reassessed again after 3 and 6 months as a follow up.

Statistical analysis: Data were collected, tabulated, statistically analyzed using an IBM personal computer with Statistical Package of Social Science version 19 (SPSS, Inc, Chicago, Illinois, USA). Quantitative data were presented in the form of mean, standard deviation and range while qualitative data were presented in the form numbers and percentages. The used tests of significance included *Paired t-test, *McNemar's test, Wilcoxon test, Marginal Homogeneity test and Spearman correlation.

- P value of >0.05 was considered statistically not significant.

- P value of <0.05 was considered statistically significant.

- P value of <0.001 was considered statistically highly significant.

Results

Table 1: Shows that; the mean age of studied sample was 44 years. The highest percentage of them (61.6%) was male. More than half of studied sample (56%) was middle education and majority of the studied sample (81.6%) was married. Nearly half of the studied sample (46%) their job nature required physical effort. Also, majority of them (82.4%) their income was less than expense. More than two third of the studied sample (70%) live in urban areas and more than half of them (56%) their personality nature was nervous.

Figure 1: Illustrated that; there was highly statistically significant difference in all protection motivation theory construct related to diabetes mellitus between pre, post and follow up intervention period with $P < 0.001$

Table 2: Explained that dietary health habits, post intervention and in follow up had a highly significant improvement as $p < 0.0001$. The percentage of good dietary health habits was improved from 18.4% in pre intervention to 39.6% in post intervention and reached to 51.6% in follow up. Also, it was observed that there was highly statistically significant increase in physical activity level as good practice increased from 25.2% pre intervention to 42.4% post intervention with $p < 0.0001$. Regarding checkup of blood glucose level there was highly statistically significant improvement in regular checkup as the

percentage of always checkup increased from 2.4% to 39.6% then to 55.6% from pre to post then to follow up, respectively. Also, the percentage of regular checkup blood pressure increased from 4.8% to 30.8% then to 46.8% from pre to post then to follow up, respectively.

Table 3: Clarified that there were high statistically significant reduction in total calories consumed, BMI, waist circumference, total cholesterol level and cumulative blood glucose during post intervention and follow up with $p < 0.0001$.

Figure 2: Represented that there was statistically significant reduction in cumulative blood glucose level among pre-diabetic patients in post intervention and follow up from 46% to 23 % respectively with P value < 0.001 .

Figure 3: Showed that there was statistically significant reduction in high and moderate risk pre-diabetic patients from post intervention to the follow up. In reverse the percentage of low risk participants increased from 24% to 59.6% in post intervention and reached to 84% in follow up intervention with P value < 0.001 .

Table 4: demonstrates that there was statistically significant negative correlation between PMT theory construct and certain modifiable risk factors of diabetes mellitus especially with total calories, weight, waist circumference and cumulative blood glucos

Table (1): Distribution of Socio-Demographic Characteristics among the Studied Sample.

Demographic characteristics	Studied sample (N=250)	
	No.	%
Age		
19 – 30	54	21.6
31 – 40	111	44.4
41 - 58	85	34.0
Mean ± SD	44.87±6.10	
Gender		
Male	154	61.6
Female	96	38.4
Educational level		
Basic education	20	8
Middle education	140	56
University & above	90	36
Marital state		
Single	34	13.6
Married	204	81.6
Widow	12	4.80
Nature of job		
Require physical effort	115	46.0
Require mental effort	92	36.6
House wife/ Not work	43	17.2
Income		
More than expense	8	3.20
Equal expense	36	14.4
Less than expense	206	82.4
Residence		
Urban	175	70
Rural	75	30
Self-reported personality nature		
Nervous	140	56.0
Medium	57	22.8
Quiet	53	21.2

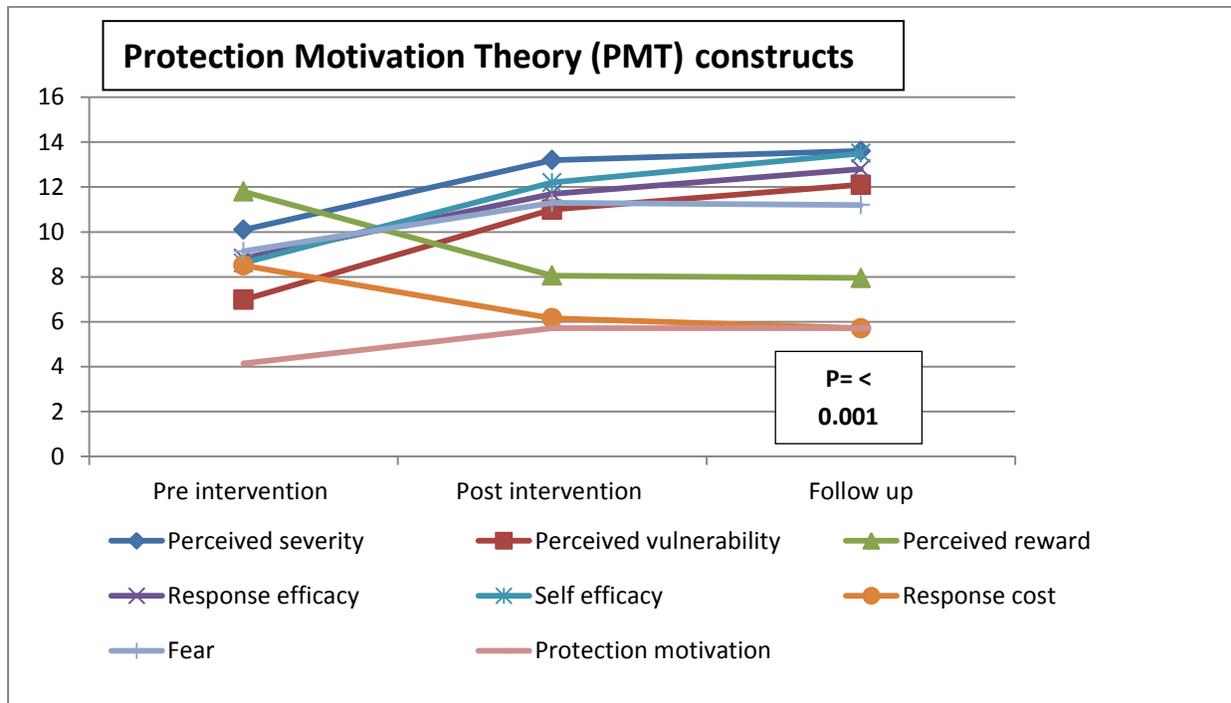


Figure 1: Mean \pm SD of Promotion Motivation Theory Constructs about Diabetes Mellitus Modifiable Risk Factors Pre, Post and Follow -up Intervention.

Table (2): Distribution of Health Related Behavior Regarding Diet, Physical Activity and Checkup Pre, Post and Follow up Intervention (N=250)

Health Related Practice	Studied Sample (N=250)			Marginal homogeneity test	P value
	Pre Intervention	Post Intervention	Follow up Intervention		
	No (%)	No (%)	No (%)		
Dietary practice					
- Bad	141(56.4)	40(16.0)	16(6.40)	11.8	P1:0.001**
- Accepted	63(25.2)	111(44.4)	105(42.0)	12.2	P2:0.001**
- Good	46(18.4)	99(39.6)	129(51.6)	7.09	P3:0.001**
Physical activity practice					
- Bad	64(25.6)	30(12.0)	18(7.20)	8.55	P1:0.001**
- Accepted	123(49.2)	114(45.6)	94(37.6)	9.31	P2:0.001**
- Good	63(25.2)	106(42.4)	138(55.2)	6.63	P3:0.001**
Smoking habits					
- Never	208(83.2)	212(84.8)	228(91.2)	4.24	P1:0.001**
- Sometimes	12(4.80)	22(8.80)	14(5.60)	5.17	P2:0.001**
- Always	30(12.0)	16(6.40)	8(3.20)	4.89	P3:0.001**

Checking blood glucose					
- Always	6(2.40)	99(39.6)	139(55.6)	13.9	P1:0.001**
- Sometimes	47(18.8)	129(51.6)	86(34.4)	13.5	P2:0.001**
- Never	197(78.8)	22(8.80)	25(10.0)	3.79	P3:0.001**
Checking blood pressure					
- Always	12(4.80)	77(30.8)	117(46.8)	13.5	P1:0.001**
- Sometimes	64(25.6)	138(55.2)	113(45.2)	13.1	P2:0.001**
- Never	174(69.6)	35(14.0)	20(8.00)	6.92	P3:0.001**

**High significant

P1: Comparison between pre intervention and post intervention

P2: Comparison between pre intervention and follow up intervention

P3: Comparison between post intervention and follow up intervention

Table (3): Distribution of Nutritional Assessment of Studied Sample Pre, Post and Follow up Intervention. (N=250)

Nutritional assessment	Studied Sample (N=250)			(%) of decrease	Wilcoxon test	P value
	Pre Intervention	Post Intervention	Follow up Intervention			
	Mean ± SD	Mean ± SD	Mean ± SD			
Total Calories (Kcals)	2351.1±347.4	1914.2±354.3	1843.8±345.8	18.5% ⁽¹⁾ 21.5% ⁽²⁾	13.7 13.6 10.3	P1:0.001** P2:0.001** P3:0.001**
BMI (kg/m²)	30.1±2.15	27.6±2.14	25.7±2.21	8.30% ⁽¹⁾ 14.6% ⁽²⁾	13.1 13.5 12.8	P1:0.001** P2:0.001** P3:0.001**
Waist circumference (cm)	86.0±6.66	81.7±7.15	78.9±7.12	5.00% ⁽¹⁾ 8.25% ⁽²⁾	13.2 13.4 13.0	P1:0.001** P2:0.001** P3:0.001**
Cholesterol level mg/dl	237.4±34.9	212.6±30.9	191.7±29.2	10.4% ⁽¹⁾ 19.3% ⁽²⁾	13.1 13.2 12.2	P1:0.001** P2:0.001** P3:0.001**
Cumulative blood glucose mg/dl	6.07±0.27	5.65±0.35	5.25±0.46	6.92% ⁽¹⁾ 13.5% ⁽²⁾	12.6 13.1 11.8	P1:0.001** P2:0.001** P3:0.001**

(1): % of decrease post intervention **High significant

(2): % of decrease follows up intervention

P1: Comparison between pre intervention and post intervention

P2: Comparison between pre intervention and follow up intervention

P3: Comparison between post intervention and follow up intervention

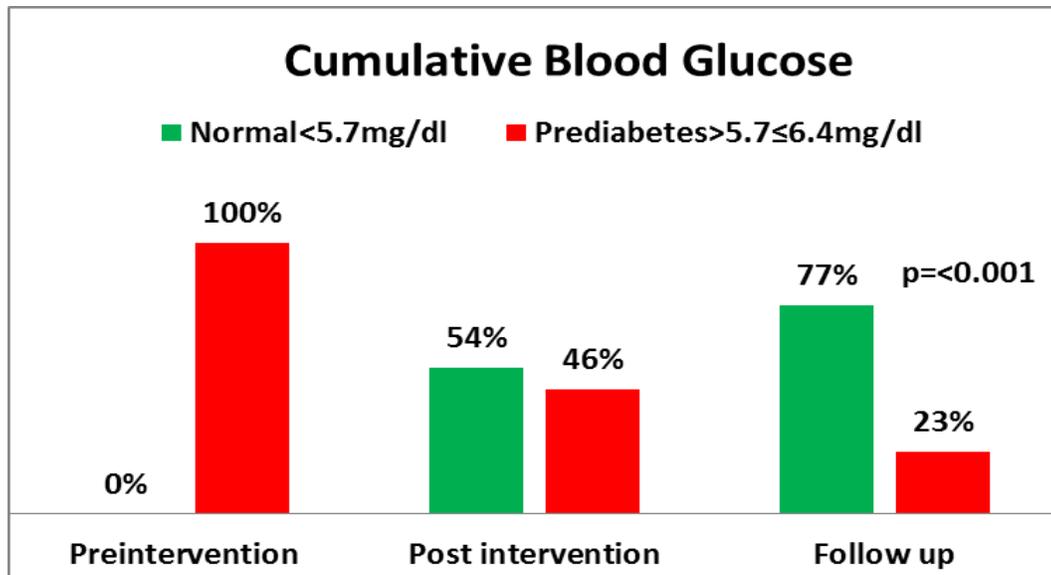


Figure 2: Distribution of Cumulative blood glucose pre, post and follow up intervention

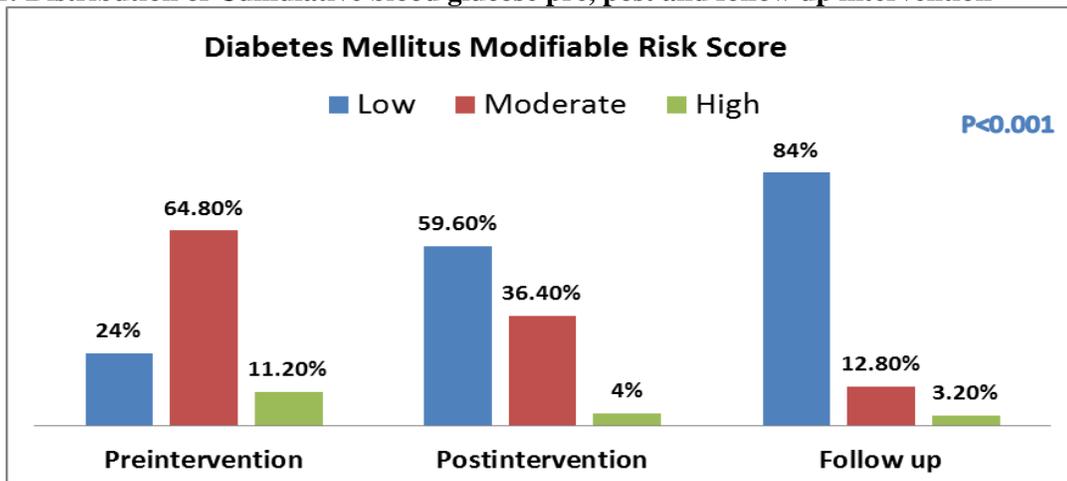


Figure 3: Distribution of Diabetes mellitus risk score pre, post and follow up intervention

Table 4: Correlation between PMT Construct and reported modifiable risk factors pre , post intervention and during follow up (N=250).

Modifiable risk factors	PMT construct (N=250)					
	Pre Intervention		Post Intervention		Follow up Intervention	
	r	P value	R	P value	r	P value
Total calories	-0.113	0.074	-0.175	0.006**	-0.196	0.002**
Weight	-0.001	0.988	0.148	0.019*	0.149	0.018*
BMI	-0.131	0.038*	-0.082	0.199	-0.014	0.827
Waist circumference	-0.276	0.001**	-0.215	0.001**	-0.217	0.001**
Cholesterol level	-0.100	0.144	-0.011	0.860	-0.002	0.979
Cumulative blood glucose	-0.003	0.98	-0.160	0.009**	-0.247	0.001**

Discussion

Globally diabetes mellitus is the major serious among the top ten causes of death among adults, as it is a long-term condition with a major impact on individuals, families and societies worldwide⁽⁸⁾.

The current study revealed positive improvement in healthy eating habits and physical activity level with reduction in the number of smoked cigarettes which indicating positive behavioral changes among pre-diabetics. The same results was obtained by **Chamroonsawadi et al., 2021**⁽¹⁵⁾ who studied “protection motivation theory to predict intention of healthy eating and sufficient physical activity to prevent diabetes mellitus in Thai population: A path analysis” and concluded that self-efficacy had a direct effect on modifying both unhealthy eating behaviors and physical activity level.

Also there was a statistically significant difference between pre, post and follow up results regarding perceived disease vulnerability as the researcher increased the pre-diabetic patients’ perception about their vulnerability to develop diabetes mellitus, in turn, a positive effect appeared on conducting preventive behavioral modification clarified through total calories consumption reduction, increased physical activity level, reduction of total number of smoked cigarettes and improved disease related screening behavior. This result is similar to results of **Vasheghani et al., 2012**⁽¹⁶⁾, **Malmir et al., 2018**⁽⁴⁾ and **Khiyali et al., 2017**⁽¹⁷⁾. So, it is important to elevate high risk groups’ knowledge level related to vulnerability to diseases development.

Statistically significant difference was also, presented post the intervention in the mean score of perceived severity as participant became insightful with DM seriousness, its health threat and its severe complications. These findings are in the same line with **Khani et al., 2022**⁽¹⁸⁾ and **Malmir et al., 2018**⁽⁴⁾. This mean that if people become aware of the consequences and harms of diabetes on their health and life, protection motivation will be effective as an educational intervention which increase perceived severity.

The screening behavior regarding regular periodical check of blood glucose & blood pressure raised in post-intervention and follow up than pre-intervention. This demonstrated the beneficial effect of nursing intervention in this regard. Similarly, this exemplified the positive impact of nursing care in this area. Similarly, **Vasheghani et al., 2012**⁽¹⁶⁾ and **Khiyali et al., 2017**⁽¹⁷⁾ who reported an increase in pap smear test screening among the women of the experimental group after the implementation of protection motivation theory based educational interventions about cervical cancer.

In addition, the study findings' revealed that the mean score of perceived reward about not performing the screening tests for early detection of DM was significantly reduce in posttest and follow up. This result is consistent with **Khani et al., 2022**⁽¹⁸⁾ findings. It seems that the reason for augmented perceived threat in this study was the emphasis of the nursing intervention on the consequences of DM and screening behavior benefits among participants. These results suggest that high-risk groups are more

probable to perform the screenings if they logically address the benefits and understand the severity and harms of the disease as well as the associated consequences.

The findings indicated that the mean score of the response of self-efficacy increased after the intervention in posttest and follow up. Self –efficacy was a strong predictive factor for screening and promoting healthy behaviors as smoking cessation, having healthy diet and increased physical activity level. This result is in agreement with **Khani et al., 2022⁽¹⁸⁾**, **Chamroonsawadi et al., 2020⁽¹⁵⁾** and **Malmir et al., 2018⁽⁴⁾** who reported the effectiveness of educational intervention on the enhancement of self-efficacy of screening behaviors for skin and breast cancers. Also, they reported that belief in high personal self-efficacy to do a behavior strongly decreased the perceived barriers for performing it.

Regarding response efficacy, a statistically significant difference was found in posttest and follow up intervention which is consistent with **Khani et al., 2022⁽¹⁸⁾** and **Malmir et al., 2018⁽⁴⁾**. They show that belief in desirable outcomes of a health behavior could lead to a better performance. Furthermore, the present study demonstrated that the mean score of response cost significantly diminished. These findings are in congruence with the findings of similar studies of **Khani et al., 2022⁽¹⁸⁾** and **Madadzadeh et al., 2018⁽¹⁹⁾**. According to the theory construct, coping appraisal is the second method considered by researchers when encountering high-risk people. In addition to the efficacy of the

prescribed response, the researcher encouraged pre-diabetic patients to assess their own efficacy level. Pre-diabetic patients' perceived response costs can be viewed as roadblocks to implementing preventative behaviors. As a result, implementing an educational nursing intervention and assisting pre-diabetics in removing obstacles can help them become more protective.

Fear was also increased from pre to post intervention and follow up. These findings was consistent with results of previous studies of **Sadeghi et al., 2019⁽²⁰⁾** who studied the predictive factors for preventing hookah smoking and health promotion among young people based on the protection motivation theory and **Khosravi et al., 2022⁽²¹⁾** who studied the prostate cancer screening behaviors and the related beliefs among 50-to 70-year-old men in Hamadan: Appraisal of threats and coping. This means that if a person be afraid of having diabetes, the motivation will increase for following protective and preventive behaviors.

The present study indicated a statistically significant difference in protection motivation scores from pre to post intervention and follow up, which is consistent with the findings of **Khani et al., 2022⁽¹⁸⁾** and **Malmir et al., 2018⁽⁴⁾** who observed that when the perceived threat and efficacy are strong, participants are more motivated to control the danger and accept the recommended response. According to the study, people approach danger with more caution and awareness as they believe the risks are substantial and that they can effectively mitigate the threat.

Through the present study in post intervention and follow up, all scores of protective motivation constructs were significantly changed which come in agreement with the results of **Khani et al., 2022** ⁽¹⁸⁾ and **Malmir et al., 2018** ⁽⁴⁾ who explained that training based on the theory of incentive protection is effective in modifying the score of the structures.

Also, there was a statically significant reduction in total calories consumption in post intervention and follow up. Similar finding was reported by **Alieva et al., 2020** ⁽²²⁾ who studied the effect of dietary components and the association with coronary artery disease risk score and reported that there was statistical significant reduction on the total calories intake post intervention. This means that nutritional educational therapy based on PMT improved not only the nutritional knowledge of individuals after intervention but also, sufficient to change behavior.

The results of present study showed that there was statically significant reduction in cumulative glucose level among pre-diabetic patients in pre, post intervention and follow up. One possible cause of this reduction may be the improved physical activity level and adherence to healthy diet. These results are consistent with studies of **Chamroonsawadi et al., 2020** ⁽¹⁵⁾ and **Najafipour et al., 2017** ⁽²³⁾. They showed that eight weeks of physical activity reduces HbA1c levels compared to the control group. The researchers explained that; careful implementation nursing intervention based on PMT can be used to help control diabetes status; in addition,

adherence to healthy diet and physical activity were increased.

Also, there was a statistically significant negative correlation between weights among pre, post intervention and follow up and PMT construct. This came in agreement with **Azami et al., 2020** ⁽²⁴⁾ and **Elkafrawi et al., 2017** ⁽²⁵⁾ as they documented that; increased weight loss and PMT construct scores after application of motivational interviewing on a weight loss program based on the protection motivation theory. The researchers concluded that obesity with high waist circumference is a major risk factor for the development of T2DM. Waist circumferences is considered a better and more convenient method than BMI in the prediction of T2DM.

As observed, all previously mentioned results pointed to all research hypotheses were supported.

Conclusion: The protection motivation sustained integrated nursing intervention had been beneficial in decreasing total risk score of diabetes mellitus among pre-diabetics improving the disease related screening behavior, improving the disease related healthy behavior as consuming a healthy diet, being physically active, reducing their weight, cholesterol & cumulative glucose level and number of smoked cigarettes.

Recommendations

- Periodic and continuous early detection and proper management of pre-diabetics should be carried out by each country-authorized personnel.
- Large-scale awareness programs should be implemented after identifying the appropriate means of message spread among pre-diabetics.

- Unraveling the mechanisms by which dietary modifications, regular physical activity and gradual weight loss specifically resolve DM various stages.
- Further studies are required before practice-changing recommendations can be made.

Limitations of the study

A self-reported tool was used for data collection so the study may not have taken into account all confounding variables.

Declaration of conflict of interest:

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