

Effectiveness of Diabetes Risk Reversal Strategies on Cognition, Attitude, and Indian Diabetes Risk Score Among People in a Community at Selected Areas of Puducherry

Dr. Punitha Josephine S¹, Vijay R², Jayaprakash S³, Dr. Vidhya Thirunavukkarasu⁴, Dr. Aruna Subramaniam⁵, Dr. Lizy Sonia Benjamin⁶

¹Principal, Kasturba Gandhi Nursing College. Sri Balaji Vidyapeeth (Deemed to be university) Puducherry, India, ORC id: 0000-0001-5991-8180, psysspj2011@gmail.com

²Tutor, Kasturba Gandhi Nursing College. Sri Balaji Vidyapeeth. (Deemed to be university) Puducherry, India, ORC id: 0009-0008-0460-3729, vijayarun0510@gmail.com

³Tutor, Kasturba Gandhi Nursing College, Sri Balaji Vidyapeeth (Deemed to be university) Puducherry, India, rithikprakash26@gmail.com

⁴M.Sc RN, RM, PhD Nursing, Assistant Professor, College of Applied Medical Sciences, ORC id:00000002-7006-3694, drvidhyatr@gmail.com

⁵M.Sc RN, RM, PhD Nursing, Reader & Head Dept. Of Community Health, Nursing Faculty of Nursing Sri Ramachandra Institute of Higher Education and Research Deemed to be University Porur, Chennai, India, ORC id:0000-0001-9427-2346. aruna.s@sriramachandra.edu.in

⁶Assistant Professor, Head of the department, Medical and Surgical Nursing, College of Nursing, ORC id : 0000-0002-2373- 5021, lizysonia17@gmail.com

ABSTRACT:

Introduction: *Diabetes Mellitus is a chronic metabolic disease that significantly impacts global health. This study evaluates the effectiveness of diabetes risk reversal strategies on cognition, attitude, and the Indian Diabetes Risk Score (IDRS) among people in a selected community at Puducherry.* **Methods:** *A quasi-experimental study with a twogroup pretest-posttest design was conducted among 40 participants (20 in study group, 20 in comparison group) selected through purposive sampling. Participants in the study group received structured diabetes risk reversal strategies (DRRS), including Spiritual Practices, Deep Breathing exercises, 30 minutes of Brisk walking, Japanese towel exercise, Dietary advices, meditation and sleep. The impact was assessed using cognition and attitude assessment tools along with IDRS.* **Results:** *The pretest mean cognition, attitude, and IDRS scores showed no significant difference between the groups. However, post-intervention, the study group exhibited significant improvements in cognition (mean difference: 6.516, $p < 0.001$), attitude (mean difference: 8.514, $p < 0.001$), and a reduction in diabetes risk (IDRS mean difference: 1.012, $p < 0.001$) compared to the comparison group.* **Discussion:** *Diabetes risk reversal strategies significantly enhance cognition and attitude while reducing diabetes risk. Implementation of such strategies at the community level can aid in early diabetes prevention.*

Keywords: *Diabetes risk reversal strategies, cognition, attitude, Indian Diabetes Risk Score,*

INTRODUCTION:

Diabetes Mellitus (DM) is a leading public health concern worldwide, characterized by chronic hyperglycemia resulting from insulin resistance and/or inadequate insulin secretion. A program aimed at reversing the risk of diabetes is essential as it has the ability to prevent or even reverse type 2 diabetes, leading to better health outcomes and a decrease in disease burden.¹ By concentrating on lifestyle modifications such as nutrition and physical activity, those at risk for diabetes may attain normal blood sugar levels without the need for medication, and possibly even reverse the disease.

Given the rising prevalence of diabetes in India, there is an urgent need to implement preventive interventions at the community level.² This study assesses the impact of diabetes risk reversal strategies on

cognition, attitude, and IDRS among middle-aged adults in a rural community of Puducherry. This study aimed to assess the effectiveness of diabetes risk reversal strategies on cognition, attitude, and Indian diabetes risk score among people in a community and to examine the associations with demographic variables. The objectives were:

to evaluate the effectiveness of diabetes risk reversal strategies on cognition, attitude, and Indian diabetes risk score among people and to associate the level of cognition, attitude, and Indian Diabetes Risk Score with the selected demographic variables.³

141

Prevention is better than cure and Diabetes risk reversal strategies are important for all the people who are at risk for diabetes mellitus. It offers a chance to improve the overall health of an individual, reduce the risk of potential complications, and reduces the chance of diabetes remission. Life style modifications assures the reduction of risk of getting diabetes mellitus by any individual. It focuses on dietary modifications and exercises with which individuals can manage their blood sugar levels. It also improves insulin sensitivity, and reverse the progression of the disease.⁴

MATERIAL AND METHODS

Study Design and Participants: A quasi-experimental two-group pretest-posttest design was used. The study was conducted in Aranganoor, Puducherry, among individuals aged 40-60 years who were at risk of developing diabetes (IDRS score 30-60). The Indian Diabetes Risk Score (IDRS) is a validated tool that assesses the risk of developing Type 2 Diabetes Mellitus (T2DM) based on modifiable and non-modifiable risk factors. Participants diagnosed with diabetes, those with severe comorbid conditions, and individuals with cognitive impairments were excluded. A total of 40 sample were recruited using purposive sampling technique among which 22 each were allocated to study and comparison group respectively. Participants in the study group received the Diabetes Risk Reversal strategies whereas comparison group were on routine care.⁵

Diabetes Risk Reversal strategies is designed by the researcher for the adults who are at risk for Type II Diabetes Mellitus, which reverses the risk of developing Type II Diabetes Mellitus. It includes the following measures as per the schedule:^{6,7,8,9}

- **Spiritual Practices:** Worship God everyday morning, nearly 10 minutes from 06.05 am to 06.15 am.
- **Deep Breathing** for 5 minutes from 06.15 am to 06.20 am. It includes deep inhalation for the count of 5, holding it for 20 counts and exhalation for another 5 counts.
- **Physical activities :** Isotonic exercise like Brisk walking for 30 minutes per day from 5.15 pm to 5.45 pm, 6 times per week with a total hour of 3 hours were practiced by each study group participants. Isometric exercise include Japanese towel exercise which refers to the contraction and relaxation of abdominal muscles twice in the evening, five minutes per slot regularly from 5.46 pm to 6 pm daily.

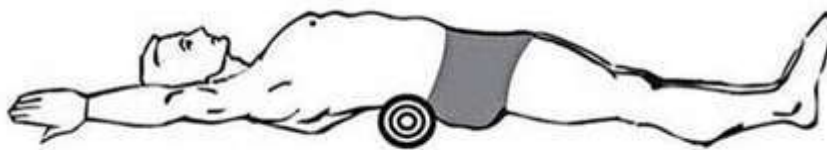


Fig: 1 Japanese towel exercise

The following are the steps of Japanese towel exercise:

- Take a medium-sized towel and roll it into a log, about 7-10 cm wide and about 40 cm long and tie a band or string around the edge and center of the rolled towel to make sure it stays put.
- Sit on a mat in flat and hard surface, stretching legs out in front of body. Feet must be shoulder-width apart and big toes should be able to touch each other.
- Place the towel behind the body and gently lie down on back holding the towel so that it is placed directly below belly button, and against the small of back.
- Stretch arms above head, palms facing down and little fingers touching. Make sure little fingers and toes are in line with each other.
- Hold this position for at least 5 minutes, keeping breathing pattern regular.

- Resume to the normal position slowly.

4. Dietary advice :

○ Study group participants had been taught to consume more complex carbohydrates namely millets, wheat with husk, etc., fresh vegetables and fruits, cereals, pulses, medium and lower glycemic index foods. It includes low glycemic index foods like Green leafy vegetables (bitter melon, snake melon, bottle gourd, brinjal, ladies finger, cluster beans, beans, ivy gourd). Medium glycemic index food such as cabbage, Plantain stem, Broad bean.

2) Meditation:

- Sit straight, close the eyes and be calm.
- Start focusing on breathing pattern.
- Everyday Practice for 05 minutes from 06.00 pm to 06.05 pm per day.

3) Sleep

- Regular night-time sleep for 7 hours per day from 10.00 pm to 05.00 am.
- Ensure the comfort place and devices for sleep.
- Ensure the room is cool and well ventilated.
- Ensure the bedroom is dark and free from noise.
- Stick to a regular bedtime (10.00 pm to 05.00 am).

All the above strategies had been practiced by the study group participants for 6 months where as comparison group participants did not receive any structured interventions. Thereafter post test on level of cognition, attitude and Indian Diabetes Risk Score were assessed. Cognition was measured using a structured questionnaire (score range: 0-30), Attitude was assessed using a 5-point Likert scale (score range: 10-50) and Indian Diabetes Risk Score (IDRS) was calculated using structured tool and overall score was categorized as low (<30), medium (30-50), and high risk (>60). Data Analysis was done using SPSS version 26 and Paired t-tests and ANOVA were performed to evaluate the impact of interventions on outcome variables..

RESULTS

In terms of age, the study group has a higher proportion of participants aged 40–45 (35%) compared to the comparison group (25%), while the 46–50 age bracket is more represented in the comparison group (30%) than in the study group (15%). Both groups have equal representation in the 51–55 age range (25%), with a slightly higher proportion of participants above 55 in the study group (25%) than in the comparison group (20%). The **habit of exercise** shows that none of the participants engage in regular exercise, with 35% having a moderately adequate cognition level and 65% having an adequate cognition level, both reporting no exercise. For **unhealthy habits**, 5% of individuals with adequate cognition report smoking, 15% have alcoholism, and 5% use tobacco or pan masala, while 15% report avoiding all of these habits, and 40% of those with adequate cognition avoid them altogether. Concerning **previous knowledge regarding diabetes mellitus**, 35% of individuals with moderately adequate cognition and 65% with adequate cognition have no prior knowledge of the condition. Similarly, for the question of whether **any family member has had diabetes mellitus**, 35% of individuals with moderately adequate cognition and 65% with adequate cognition report that no one in their family has had diabetes.

Table 1: Distribution of level of attitude among people at selected community area in study group.

S. No	Level of attitude	Study Group (n=20)	
		Pre-test	Post-test

		f	%	f	%
1.	Unfavourable	4	20	0	0
2.	Moderately favourable	16	80	6	70
3.	Favourable	0	0	14	30

Table 2 : Distribution of level of cognition among people at selected community area in comparison group

S. No	Level of cognition	Comparison Group (n=20)			
		Pre-test		Post-test	
		f	%	f	%
1.	Inadequate	4	20	4	20
2.	Moderately adequate	16	80	16	80
3.	Adequate	0	0	0	0

Table 3 : Distribution of Indian Diabetic risk score among people at selected community area in study group.

S. No	Indian Diabetic score	Study Group (n=20)				Comparison group (n=20)			
		Pre-test		Post-test		Pre-test		Post-test	
		F	%	F	%	F	%	F	%
1.	Low risk	0	0	4	0	0	0	0	0
2.	Medium risk	4	80	16	0	4	20	5	25
3.	High risk	16	20	0	0	16	80	15	75

Table no 3 the paired “t” value on comparison of cognitive , attitude and Indian diabetic risk score within study group revealed that the mean cognition score increased from 18.55 (SD = 3.26) in the pre-test to 24.90 (SD = 3.22) in the post-test. The paired t-test value of 17.076 and a p-value of 0.000* indicate a statistically significant improvement in cognitive levels. The mean attitude score increased from 30.20 (SD = 4.33) in the pre-test to 43.25 (SD = 5.35) in the post-test. The paired t-test value of 12.429 and a p-value of 0.000* also reflect a statistically significant improvement in attitudes. The mean IDRS score improved from 64.00 (SD = 8.82) in the pre-test to 68.90 (SD = 6.20) in the post-test. The paired t-test value of 14.642 and a p-value of 0.000* confirm a significant reduction in diabetic risk levels.

These results demonstrate that the intervention was highly effective in improving cognition, attitudes, and reducing diabetic risk among the study group participants, with all changes being highly statistically significant ($p < 0.001$).

Table 4 : Comparison of cognitive , attitude and Indian diabetic risk score between the study group and comparison group in Pretest. (N = 40)

S.NO.	Dependant variables	Study Group(n=20)		Comparison Group(n=20)		Unpaired value	‘t’ p value
		Pre-test		Pre-test			
		Mean	SD	Mean	SD		
1.	Cognition	18.55	3.26	18.00	2.00	0.642	0.525
2.	Attitude	30.20	4.33	29.05	3.66	0.906	0.371
3.	IDRS	64.00	8.82	62.00	8.94	0.712	0.481

$p > 0.05$ - Non-Significant.

Table no 4 the independent “t” value on comparison of pre test scores between study and comparison group unveiled that the mean cognition score in the study group was 18.55 (SD = 3.26), while in the comparison group, it was 18.00 (SD = 2.00). The unpaired t-test value of 0.642 and a p-value of 0.525 indicate no significant difference in cognition between the groups. The mean attitude score in the study group was 30.20 (SD = 4.33), compared to 29.05 (SD = 3.66) in the comparison group. The unpaired t-test value of 0.906 and a p-value of 0.371 suggest no significant difference in attitudes between the groups. The mean IDRS score in the study group was 64.00 (SD = 8.82), while in the comparison group, it was 62.00 (SD = 8.94). The unpaired t-test value of 0.712 and a p-value of 0.481 confirm no significant difference in diabetic risk scores between the groups. These findings indicate that the study and comparison groups were comparable in terms of cognition, attitude, and IDRS at baseline, with no significant pre-test differences ($p < 0.05$).

TABLE 5 : Comparison of level of cognition, attitude and IRDS between study and comparison group N = 40

S.NO.	Dependant variables	Study Group		Comparison Group		Unpaired value	‘t’ p value
		Post-test		Post-test			
		Mean	SD	Mean	SD		
1.	Cognition	24.90	3.22	18.70	2.77	6.516	0.000*
2.	Attitude	43.25	5.35	30.90	3.66	8.514	0.000*
3.	IDRS	68.90	6.20	61.00	9.11	1.012	0.000*

Table no 5 the independent “t” value on comparison of post test scores depicts that the mean cognition score in the study group was 24.90 (SD = 3.22), significantly higher than the comparison group’s mean score of 18.70 (SD = 2.77). The unpaired t-test value of 6.516 and a p-value 0.000* indicate a highly significant difference.

The mean attitude score in the study group was 43.25 (SD = 5.35), notably higher than the comparison group’s mean score of 30.90 (SD = 3.66). The unpaired t-test value of 8.514 and a p-value of 0.000* highlight a highly significant improvement in attitude in the study group. The mean IDRS score in the study group was 68.90 (SD = 6.20), compared to 61.00 (SD = 9.11) in the comparison group. The unpaired t-test value of 1.012 and a p-value of 0.000* reflect a statistically significant reduction in diabetic risk in the study group. These results indicate that the intervention significantly improved cognition, attitude, and reduced diabetic risk in the study group compared to the comparison group, with all differences being highly statistically significant ($p < 0.001$). The baseline characteristics of both groups were comparable. Post-intervention results indicated significant improvement in cognition, attitude, and diabetes risk scores in the study group.

DISCUSSION

Diabetes Risk Reversal Strategies were implemented among individual between 40 to 60 years with the Indian Diabetes Risk Score between 30 and 60. It was aimed to reduce the IRDS through enhancement of Cognition, Attitude towards Diabetes Risk reversal Strategies.

The Distribution of level of Cognition among study group participants (n=20) revealed that 15 (75%) had moderately adequate knowledge in that pretest whereas 13 (65%) had adequate knowledge in the Posttest. Contrastingly each 16 (80%) in the comparison group participants had moderately adequate knowledge in both Pre and Posttest. The Distribution of level of attitude among study group participants unveiled that 16 (80%) had moderately favorable attitude in Pretest and 14 (30%) had favorable attitude in Posttest. But in comparison group 20 (100%) had moderately favorable attitude and none had favorable attitude towards Diabetes Risk Reversal Strategies. This shows that Diabetes Risk Reversal Strategies has improved the level of Cognition and Attitude among study group participants which was implemented for 3 months after Pretest.

With regards to the Indian Diabetes Risk Score 4(80%) and 16 (20%) study group participant were under medium risk and high risk respectively in Pretest but in Posttest majority of 16 (20%) had been categorized under medium risk and none were under high risk category. In term of comparison group 16 (80%) participants were categorized as “High Risk” in Pretest whereas in Posttest it was 15 (75%). These finding unveiled that Diabetes Risk Reversal Strategies have improved the Diabetes Risk Score to the medium risk category for majority of study group participants from high risk category.

Though most of the study participants had moderate awareness and attitude about the diabetes risk reduction strategies most of them had high Indian Diabetes Risk Score¹⁰. It reveals that practice of diabetes risk reduction strategies by the study participants were less and it mandates the strict compliance with physical exercises. Regular exercises increase the tissue sensitivity to insulin and yields a beneficial effect on glycemic control thereby risk of contracting diabetes mellitus is reduced.^{11,12}

The paired “t” value on comparison of Cognition (t=17.07), Attitude (t=12.42) and IRDS (T=14.46) between Pretest and Posttest among study group participants revealed the statistically highly significant difference at $p \leq 0.001$. The comparison of Cognition, Attitude and IRDS among comparison group between Pretest and Posttest revealed no significant difference. It shows that Diabetes Risk Reversal Strategies which was implemented for study group participants had improved the Cognition, Attitude and IRDS from Pretest to Posttest, whereas in comparison group no improvement found out in Posttest.

The Effectiveness of IRDS were evaluated using independent “t” test to compare the Cognition, Attitude and IRDS between study and comparison group. Both study and comparison group participants had no significant difference in the Pretest on Cognition, Attitude and IRDS where as in Posttest highly statistically significant difference enlisted at $p \leq 0.001$. The independent “t” value on comparison of Posttest Cognition, Attitude and IRDS between study and comparison group were t=6.51, 8.51 and 1.01

respectively. It is evident from these findings that Diabetes Risk Reversal Strategies had yielded significant improvement in Cognition, Attitude and IDRS among study group participants.

These Findings are consistent with the study conducted by Meyer, M.L, et.al (2022) which revealed¹³ that structured group 50 interventions had reduced the individual risk of Type 2 Diabetes Mellitus $p \leq 0.001$. Aerobic and resistance training has a significant impact over the insulin resistance and sensitivity. Because physical activity helps the body cells to respond better to insulin and regulates the blood sugar. It also reduces the body weight which further reduces the insulin resistance^{14,15}. The diabetes risk reduction strategies which was designed and executed for the study group participants by the investigator was strictly complied by all the study group participants. Above all most of the study group participants expressed that practice of DRRS had enhanced their physical well being which motivated them to practice regularly. This ensures the regular practice of DRRS by all the study group participants. This study findings reiterate the importance of enhancing the understanding and practice of DRRS by all the people who are at risk for diabetes mellitus type 2. The findings align with Khandelwal et al. (2020), who demonstrated¹⁶ that structured lifestyle interventions, including diet and physical activity, significantly improved cognitive function and reduced diabetes risk over 12 months.

Hence **H1** “Diabetes Risk Reversal Strategies have an impact on Cognition among people at Selected Rural area in Puducherry”, **H2** “Diabetes Risk Reversal Strategies have an impact on Attitude among People at Selected Rural area in Puducherry” and **H3** “Diabetes Risk Reversal Strategies have an impact on Indian Diabetes Risk Score among People at Selected Rural area in Puducherry” are accepted. The study also examined the association of cognition, attitude, and IDRS with demographic variables. Results revealed no significant association, suggesting that factors like education and income did not influence diabetes risk reversal outcomes. This aligns with Krishna et al. (2021), who found that sociodemographic factors influenced health cognition and risk perception, with lower education and income linked to higher diabetes risk. These findings highlight the need for targeted public health interventions focusing on awareness and prevention strategies, particularly for high-risk populations.¹⁷

Current scenario of work stress and life style are the real threats for health of the people. DRRS including Spiritual Practices, Deep Breathing exercises, 30 minutes of Brisk walking, Japanese towel exercise, Dietary advices, meditation and sleep have to be strictly complied by all the people who are under risk for type 2 diabetes mellitus to promote their well being and to prevent the type 2 diabetes mellitus.^{18,19} The findings suggest that structured diabetes risk reversal strategies significantly improve cognition and attitude while reducing diabetes risk. These results align with previous studies that emphasize the role of lifestyle interventions in preventing T2DM.^{20,21} The observed improvements in cognition may be attributed to increased awareness and knowledge dissemination during the intervention sessions. Attitude changes could result from improved motivation and self-efficacy. The reduction in IDRS is promising, highlighting the effectiveness of non-pharmacological approaches in diabetes prevention.^{22,23}

STRENGTHS AND LIMITATIONS:

Strengths: The study provides evidence-based community-level interventions for diabetes prevention.

Limitations: Small sample size, short follow-up period, and self-reported measures for dietary adherence.

CONCLUSION

The study concludes that diabetes risk reversal strategies can effectively improve cognition, attitude, and reduce diabetes risk scores. Future research should focus on large-scale interventions with long-term follow-ups to confirm these findings.

DECLARATIONS

Funding

No organization provided the authors with support for the work they submitted. No financial support was obtained to help prepare this manuscript, nor was no Funding obtained to carry out this investigation.

Author contributions

Conceptualization, Dr. Punitha Josephine S

Methodology, Dr. Punitha Josephine S

SPSS Version 21.0; Validation, Dr. Punitha Josephine S, Mr. Vijay R and Mr. Jayaprakash S

Conflicts of interest

- The authors declare no conflict of interest

Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Ethics approval

Kasturba Gandhi Nursing College review board gave its approval for this study. The study period was April 2023 to May 2024 (approval number KGNC/IHEC/2024/032)

REFERENCES:

- 1.Santos, A. L., Pereira, A. L., & Sousa, J. R. (2023). Type 2 diabetes mellitus in Europe: A review of epidemiology, risk factors, and management strategies. *Journal of Clinical Medicine*, 12(5), 1876
- 2.Cloete, L. (2022). Diabetes mellitus: an overview of the types, symptoms, complications and management. *Nursing Standard (Royal College of Nursing (Great Britain): 1987)*, 37(1), 61–66.
- 3.Wei, J.-P., Wang, Q.-H., Zheng, H.-J., & Wei, F. (2018). Research progress on non- drug treatment for blood glucose control of type 2 diabetes mellitus. *Chinese Journal of Integrative Medicine*, 24(10), 723–727.
- 4.Diabetes Prevention Program Research Group. (2002). Reduction in the incidence of Type 2 diabetes with lifestyle intervention or metformin. *New England Journal of Medicine*, 346(6), 393-403.
5. Pakpour V, Molayi F, Nemati H. Knowledge, attitude, and practice of pre-diabetic older people regarding pre-diabetes. *BMC Geriatr [Internet]*. 2024;24(1):264.
- 6.Rajan R, Muthunayanan L. Diabetes Susceptibility Assessment Using the Indian Diabetes Risk Score: A Cross-Sectional Analytical Study on Young Medical Students in Chennai, South India. *Cureus*. 2023 Dec 1;15(12):e49795.
- 7.Lovic D, et al. Prevalence of diabetes mellitus: A global perspective. *Diabetes Metab Res Rev*. 2020;36(5):e3319.
- 8.Lin LJJ, Saliba B, Adams J, Peng W, et al. Diabetes prevalence and risk factors associated with diabetes among first-generation Chinese international migrants: A review of the literature. *Diabetes Res Clin Pract*. 2023; 183:109069.
- 9.Kaur, S., Gupta, R., & Kaur, G. (2020). Prevalence of diabetes distress and associated factors in type 2 diabetes mellitus: A systematic review and meta-analysis. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 14(6), 1703-1709.
- 10.Wilson, V., & Nittoori, S. (2020). Risk of type 2 diabetes mellitus among urban slum population using Indian Diabetes Risk Score. *The Indian Journal of Medical Research*, 152(3), 308.
- 11.Hussain, A., & Basit, A. (2019). Risk factors for type 2 diabetes mellitus in Europe: A narrative review. *BMC Endocrine Disorders*, 19(1), 76.
- 12.Pakhale, S., Patel, S., & Kannan, A. (2020). Risk factors for type 2 diabetes mellitus in urban India: A cross-sectional study. *Journal of Diabetes Research*, 2020, 1-7.
- 13.Meyer, M. L., et al. (2022). Effectiveness of Lifestyle Interventions in Preventing Type 2 Diabetes in LMICs. *The Lancet EClinicalMedicine*, 53, 100706.
- 14.Choudhury, S. R., Deka, P., & Ghosh, S. (2021). Prevalence of diabetes distress and associated factors among type 2 diabetes mellitus patients in India: A systematic review and meta-analysis. *Indian Journal of Community Health*, 33(4), 573-580.
- 15.Basu S, Maheshwari V, Roy D, Saiyed M, Gokalani R. Risk assessment of diabetes using the Indian Diabetes Risk Score among older adults: Secondary analysis from the Longitudinal Ageing Study in India. *Diabetes Metab Syndr*. 2024 May;18(5):103040.
- 16.Khandelwal S, Gupta P, Sharma M, et al. Effectiveness of lifestyle interventions on diabetes risk and cognitive function among individuals at high risk for Type 2 diabetes: A randomized controlled trial. *Diabetes Res Clin Pract*. 2020;166:108289.
- 17.Krishna, A., Patel, S., Kumar, R., & Sharma, P. (2021). Socio- Demographic determinants of health cognition: A study. *Journal of Health Behavior and Public Health*, 12(3), 45-67.
- 18.Chawla, Sumit, et al. "Impact of health education on knowledge, attitude, practices and glycemic control in type 2 diabetes mellitus." *Journal of Family Medicine and Primary Care*, vol. 8, no. 1, Jan. 2019, p. 261
19. Nguyen AT, Pham HQ, Nguyen TX, Nguyen TTH, Nguyen HTT, Nguyen TN, et al. Knowledge, attitude and practice of elderly outpatients with type 2 diabetes mellitus in national geriatric hospital, Vietnam. *Diabetes Metab Syndr Obes [Internet]*. 2020;13:3909–17.
- 20.Peter PI, Steinberg WJ, van Rooyen C, Botes J. Type 2 diabetes mellitus patients' knowledge, attitude and practice of lifestyle modifications. *Health SA Gesondheid [Internet]*. 2022 [cited 2024 Dec 19]
- 21.Garg R, Chawla SS, Kaur S, Bharti A, Kaur M, Sooin D, et al. Impact of health education on knowledge, attitude, practices and glycemic control in type 2 diabetes mellitus. *J Family Med Prim Care [Internet]*. 2019 [cited 2024 Dec 19];8(1):261.
- 22.Santos, A. L., Pereira, A. L., & Sousa, J. R. (2023). Type 2 diabetes mellitus in Europe: A review of epidemiology, risk factors, and management strategies. *Journal of Clinical Medicine*, 12(5), 1876.
- 23.Miller, W. L., & Chin, M. (2025). Impact of Lifestyle Interventions on T2DM Risk and Glycemia in High and Low Genetic Risk Groups. *The Journal of Clinical Endocrinology & Metabolism*, 110(1), 130-140.