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Diabetes and prediabetes individuals on therapeutic carbohydrate restriction how digital application contributed improved glycaemic levels in the developing country

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Abstract
Digital nutrition therapy that monitors or provide recommendations on diet have been found to be effective in managing Diabetes. However, there is less evidence on how integration of personalized nutrition recommendations impacts glycemic control among individuals with diabetes and prediabetes. Prospective observational study of individuals who took consultation and followed the program for 3 months were included in the study. Participants followed the program were compared to their own baseline measures taken before the intervention, to assess any improvement or decline in the lab values (HbA1c, FBS, ABG), diabetic medication post program completion. 172 participants with 112 males and 60 females (mean age 48.1±12.3) were assessed. The mean BMI of the study group was 28.6±2.9kg/m2. Of them 138 patients were diabetic with (mean initial HbA1c 8.96±1.93, FBS 179.7±67.3, & ABG 186.1±61.0) and 34 patients were prediabetic individuals with (mean initial HbA1, 6.27±0.13, FBS 154.1±54.1, & ABG 172.5±49.9) at initial consultation. After following program for 3 months with Therapeutic carbohydrate restriction there was a significant difference ($p<0.000$) among the participants with final blood glucose levels of diabetic (mean final HbA1c 6.48±0.72, FBS 122.2±30.1, & ABG 130.4±32.0) and prediabetic (mean final HbA1, 5.25±0.24, FBS 102.7±14.5, & ABG 116.2±20.3). Also, there was a change in medication dosage (36% individuals have been recommended to reduce the medication dosage, and 26% individuals' have advised to stop medication upon carbohydrate restriction post program completion. Thus, this digital therapeutic program can be considered as an effective tool for improving glycaemic control in people with diabetes & Prediabetes.

Keywords: Diabetes, prediabetes, Mfine app, meal images, monitoring**,** Digital-nutrition, Glycemic control, Nutrition therapy, Diabetes care program

Introduction

According to 2021 International Diabetes Federation (IDF) statistics, there are 537 million adults (20-79 years) living with diabetes (1 in 10). This number is predicted to rise 643 million by 2030 and 783 million by 2045. Over 3 in 4 adults with diabetes live in low- and middle-income countries and it is responsible for 6.7 million deaths in 2021. 541 million adults have impaired glucose tolerance (IGT), which causes them for risk of type 2 diabetes [1-4]. However, prediabetes is an intermediate state of hyperglycaemia with glycaemic parameters above normal but below the diabetes threshold [5]. Early diagnosis and intervention of prediabetic and their cluster of risk factor can prevent the cardiovascular events and complications of diabetes such as diabetic retinopathy, neuropathy, and nephropathy [6]. Physical inactivity and nutritional transition along with increased consumption of refined carbohydrates, processed foods, led to the increased prevalence of diabetes in India [7].

Researchers have been documenting the use of mobile phones as Behaviour Change Communication (BCC) tools for encouraging physical activity and healthy diets, combating depression, quitting smoking, and managing diabetes and other non-communicable diseases (NCDs), while on the one hand, proliferation of information and communication technologies (ICTs), more profusely that of mobile phones, is blamed in part for physical inactivity and associated lifestyle diseases [8]. The advances in mobile technology have led to the concept of mobile-health (mHealth) and use of mobile phones as an important platform for the delivery of health communication interventions. Multiple studies have shown the successful use of mHealth in managing various health conditions [9, 10]. Digital health technologies that incorporate nutrition education and monitoring have gained increasing popularity to change and manage dietary choices **(11-13).** Number of calories counting apps developed in various countries are available in the mobile play stores claiming to help in weight management, diabetes management. However, the number of studies that analysed their quality and effectiveness is very limited in developing countries, and very few such studies have been done in India. This study aimed at analysing the quality and effectiveness of diabetes care program in glycaemic control delivered through MFine application in Indian scenario and to get an understanding the short-term effects of a modified lifestyle in diabetes management.

Objectives

- The Objective of the study was to assess the quality and effectiveness of Mfine Diabetes care program in improving glycaemic levels among diabetes and prediabetes individuals.
- The primary outcome of the study was to analyse the changes in the haemoglobin A1c (HbA1c) levels, FBS,

ABG and medication changes after completion of the program as compared to those in the baseline.
- We also focused on evaluating the effect of therapeutic carbohydrate restricted diet and the short-term effects of a modified lifestyle by using the changes in the body weight of study individuals after program completion.

Methodology

Prospective observational study of individuals who took consultation and followed the program for 3 months were included in the study. During the programme, patients were counselled via video calls with both Diabetologist and Clinical dieticians. Educated with weekly follow-ups, daily meal plate guiding pictures and monitored their food plate images with Mfine application. The study aims to evaluate the effectiveness of digital Diabetes care program delivered through Mfine application on individuals who are diabetes and prediabetes, using initial and final lab test (consists of HbA1c, Fasting and ABG) as a part of program. All participants followed the program were compared to their own baseline measures taken before the intervention, to assess any improvement or decline in the lab values, post program completion. The before-after design was used to evaluate changes in outcomes over time.

Mfine Mobile/web application has a user-friendly interface that helps curate user databases like anthropometric measurements (height and weight) and the system calculates the Body Mass Index for them. They can log their details with the help of AI for adding details like - medical conditions, 24-hour dietary details, physical activities, and medication details. They can also upload their medical test report in the application - the system database records this information in the participant's profile. Users are provided access to evidence-based educational Content like blogs and videos created by experts like Doctors, Clinical Dietitians, etc. Users get personalized medical and dietary prescriptions and weekly exercise session access throughout the course of the program (3 months).

Study Design

Prospective observational study was performed with convenient sample technique. Among the total enrolled patients, (n=172) patients completed 3 months paid diabetic care program on Mfine application were selected for the study from November 2021 to December 2022. The clients were recruited from various locations across India who themselves enrolled for the program.

Sample collection

Sample was collected through the Mfine application via video call during the consultations by certified and trained Clinical Dieticians and Diabetologists who were onboard with Mfine as practicing doctors.

Nutritional screening and assessment

To evaluate nutritional status, each participate was initially screened and assessed at time of initial assessment by CT (Care team) Dietician and Senior Consultant Dietician during consultation as a part of Mfine protocol. The assessment includes interpretation of anthropometric, biochemical (laboratory), clinical and detailed dietary history.

Dietary Approach

Therapeutic carbohydrate restriction (<130gm of dietary carbohydrate) is the primary nutrition therapy applied for the targeted individuals in the study. We recognize that levels of carbohydrate tolerance vary between individuals and even in one person over time. For example, a very low-carbohydrate ketogenic diet (VLCKD) is defined as comprised of 20 to 50 g/d carbohydrate, is advised for individuals who has sufficient protein intake per/kg body weight. The advised therapeutic restriction of total carbohydrate was 110-130gm/day, 50 to 70gm/day and 20-50gm/day as per patient's body weight and daily protein intake satisfaction. The main principle of the CRD was to eliminate carbohydrate-rich foods once or twice a day at breakfast and dinner, or at breakfast and lunch. Table shows the list of foods that the subjects were instructed to restrict/avoid.

Meal Plate Assessment

The Users' progress is checked by assessing the meal images shared by them after the personalized dietary prescription provided by the senior dietitian. A team of dietitians and health coaches constantly monitors participants' updates and evaluates them by giving the right suggestions to improve their meals and correct their macro nutrient intake.

Inclusion and Exclusion criteria

Patients diagnosed with diabetes and prediabetes were included in the study. (HbA1c levels >6.5%, >5.6% respectively). Adults age ≥ 18yrs voluntarily enrolled and completed paid 3 months, diabetes program through Mfine platform. Having a smartphone and willing to utilize the mobile app were included in the study. Whereas Chronic diabetic patients who required hospitalization. Patients with severe sensory deficits (visual, auditory, or motor) which would affect digital consultation. Presence of severe complications (eg, end-stage chronic kidney failure, chronic liver disease), history of unstable angina pectoris or stroke within the past 6 months, and history of surgical procedures, which can affect the ability to follow a dietary regimen were excluded from the study.

Ethical Clearance

The study was approved by Ethical Committee. (ethics approval number: DCGI Reg. No. ECR/141/Indt/KA/2013/RR-19).

Statistical Analysis

SPSS Windows version 24.0 was used for statistical analysis. Mean and SD and 95% Confidence Interval values were calculated for quantitative and normality characteristics variables, median and IQR were calculated for non-normal variables. Percentages were calculated for qualitative variables. Mean values of HbA1c, FBS, ABG, BMI, Initial & Final Body weight, carbohydrate restriction were compared by initial and post program completion using paired t test/ Wilcoxon signed-rank test was performed. Chi-square test was performed to study the association of HbA1c Carbohydrate restriction. Effect size was calculated for diabetic, pre diabetic and total of initial and final values of HbA1c, FBS and ABG. Level of significance was considered as 0.05.

Results and Discussion

A total of 172 patients out of 702 were recruited for the study. Five thirty patients were excluded because of various reasons like incomplete data, didn't followed the diet as advised, didn't completed 3 months of the program etc., (fig 1).

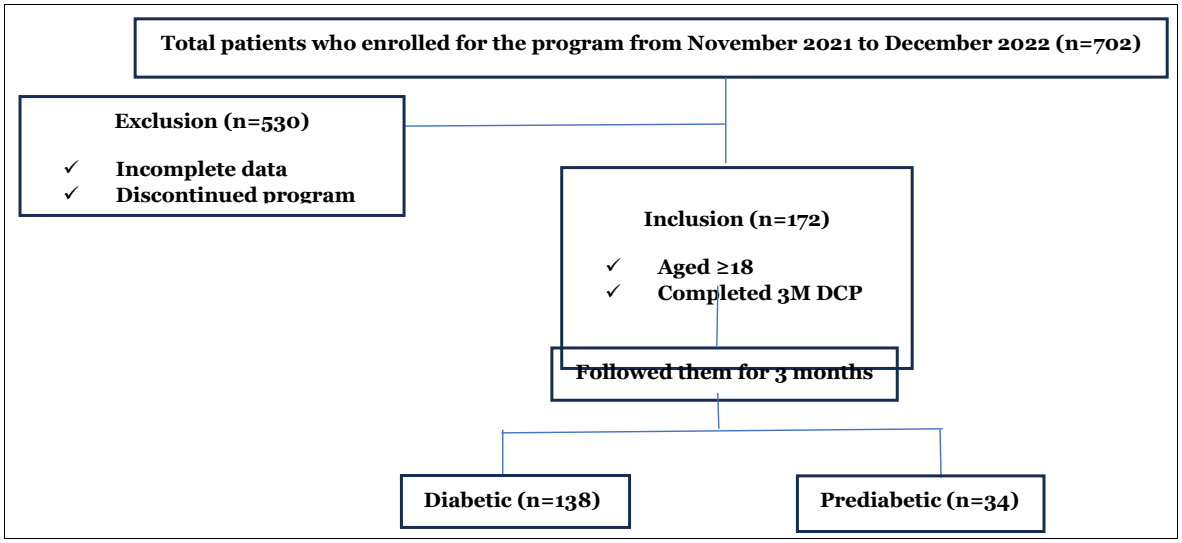

Fig 1: Flow diagram of patients selected for analysis. DCP – Diabetes care program

General characteristics of patients

In the study, the subjects were categorized as diabetes and prediabetes individuals as shown in table -1. Of the total participants 172 members included and completed 3 months of the program. They are between the age groups of 27 to 74 (mean age 48.1±12.3) years. The study population consisted of 112 males and 60 females (table -1). Among 172 subjects, 141 of the individuals have one or more co-morbidities. 55 individuals have been diagnosed with dyslipidaemia, 36 of them are hypertensive and 29 of them have thyroid related issues (hyper or hypo thyroid) as shown in (fig 2).

Table 1: General characteristics of patients

Characteristics of study population			
Gender	**Number of participants (%)**	**Mean Age ± SD**	**Age in years (Range)**
Male	112 (65)	46.3±12.2	28-73
Female	60 (35)	51.5±11.9	27-74
Total	172 (100)	48.1±12.3	27-74
Characteristics of Diabetic and prediabetic individuals			
	Type II DM	**Prediabetic**	**p- value**
Age			
≤39	n=39(73.6)	n=14(26.4)	0.144
≥40	n=99(83.2)	n=20(16.8)	
Gender			
Male	n=89(79.5)	n=23(20.5)	0.730
Female	n=49(81.7)	n=11(18.3)	
BMI (kg/m2)			
<27.5	n= 52(78.8)	n= 14(21.2)	0.707
≥27.5	n=86(81.1)	n=20(18.9)	
Mean BMI (±)	28.6 ± 2.8	28.7±3.0	0.884
Mean (±) Body weight (kgs)			
Initial	75.3±13.3	81.5±14.7	0.017
Final	70.8±12.7	75.6±13.5	0.053
HbA1c (%) Mean±SD			
Initial	8.96±1.93	6.27±0.13	0.000
Final	6.48±0.72	5.25±0.24	0.000
FBS			
Initial (±)	179.7±67.3	154.1±54.1	0.041
Final (±)	122.2±30.1	102.7±14.5	0.000
ABG			
Initial (±)	186.1±61.0	172.5±49.9	0.230
Final (±)	130.4±32.0	116.2±20.3	0.014

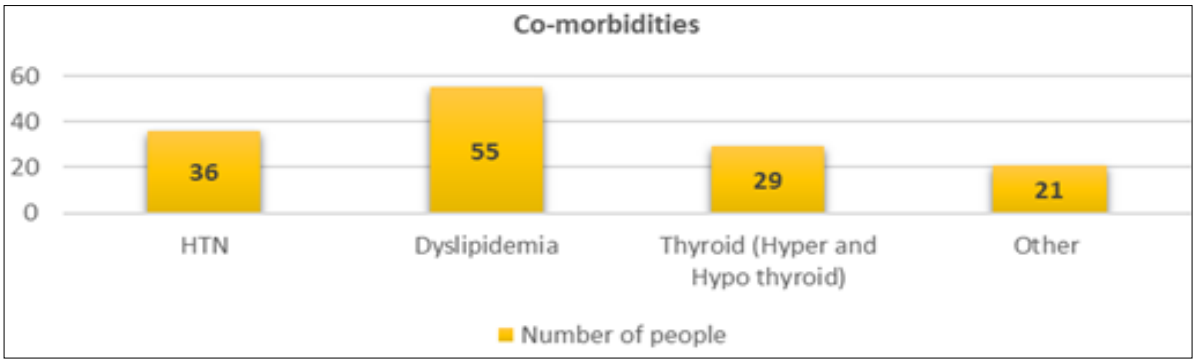

Fig 2: Number of comorbidities

A paired sample t-test was conducted to evaluate the efficacy of the digital nutrition therapy intervention on the diabetic parameters in the Mfine Diabetes care program. Table- 4 shows that the average parameters at baseline was HbA1c (8.43±2.04), FBS (174.7±65.58) and ABG (183.4±59.14) is higher than the average parameters of HbA1c (6.24±0.81), FBS (118.3±28.77) and ABG (127.6±30.55) after the program intervention. This demonstrates that following programme intervention, the HbA1c, FBS, and ABG levels were significantly reduced., t=17.861 (171), 12.908 (171), 12.915 (171), p=.000 (two-tailed) and reduced parameters on NPar Test (Wilcoxon Signed Ranks Test) indicate improvement in glycaemic parameters. The effect size is large (Cohen's d= 1.36) for HbA1c, indicating the large impact of the DCP intervention on the program clients (table-2).

Changes in HbA1c Levels after Program Completion

A significant mean reduction in HbA1c levels by 2.19% (SD 1.61%) (p<0.001) was observed in all the participants—from a baseline mean of 8.43% (SD 2.0%) to 6.24% (SD 0.81%) after the program (table 1&2). 42.4% (73/172) reached the recommended target of HbA1c 6% showed an average HbA1c reduction by 1.7% (SD 1.38) (P<0.001).

Changes in Weight after Program Completion

The participants showed a significant mean weight reduction by 4.8 (SD 5.78) kg from a pre-program mean weight of 76.5 (SD 13.81) kg to 71.8 (SD 13.04) kg after the program (P<.001). Weight reduction was observed in 88.3% (152/172) of the participants, with 59.9% (103/172) having weight loss of ≥4% & with 40.1 % (69/172) having weight loss of % <4%.

Therapeutic Carbohydrate Restriction and HbA1c reduction

A significant mean reduction in HbA1c levels by 2.12% (SD 1.3) (p-0.000) was observed in all the participants who followed 110-130gm of carbohydrate (n= 118/172)—from a baseline mean of 8.48% (SD 1.49%) to 6.36% (SD 0.61%). Whereas who have been advised for 50 to 70gm of carbohydrate restriction (n=47/172), the mean reduction in HbA1c levels have been observed by 2.5% (SD 2.1) (p-0.000) —from a baseline mean of 8.6% (SD 3.0%) to 6.0% (SD 1.14%). Similar results were obtained with the restriction of 20-50gm (n=7/172), the mean reduction in HbA1c levels were observed by 1.0% (SD 0.2) (p-0.000) —from a baseline mean of 6.3% (SD 0.16%) to 5.2% (SD 0.2%) after the program (table 3).

Changes in diabetic medication after Program Completion

Of the 172 total patients, 143 were taking various diabetes medications, whereas 29 patients were in the prediabetic stage and thus not taking any medication. Among 143 participants, a total of (n=37, 26%) were recommended to discontinue their medication upon carbohydrate restriction diet on post program completion. Similarly, (n=52, 36%) individuals diabetic medication dosage has been reduced post program completion Table (4).

Table 2: Comparison between the means of pre and post program scores, the level of significance and effect size as measures of efficacy of DCP (n=172)

		Mean	SD	Paired Differences					T	df	Sig. (2 tailed)	Cohen's Effect Size
				Mean difference	SD	Std. Error Mean	95% Confidence Interval of the Difference					
							Lower	Upper				
HbA1c	Initial	8.43	2.04	2.19174	1.60936	0.12271	1.94952	2.43397	17.861	171	0.000	1.362
	Final	6.24	0.81									
FBS	Initial	174.7	65.58	56.35471	57.25852	4.36592	47.73667	64.97275	12.908	171	0.000	0.984
	Final	118.3	28.77									
ABG	Initial	183.4	59.14	55.8058	56.6680	4.3209	47.2767	64.3350	12.915	171	0.000	0.985
	Final	127.6	30.55									

Table 3: Carbohydrate restriction and HbA1c reduction

		Paired Differences							Sig. (2- tailed)
		Mean difference	SD	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper	Minimum	Maximum	
110-130gm/day	Initial HbA1c	8.4829	1.49299	0.13744	8.2107	8.7551	6.00	13.60	0.000
	Final HbA1c	6.362	0.6167	0.0568	6.249	6.474	4.8	7.7	

50-70gm/day	Initial HbA1c	8.6340	3.01304	0.43950	7.7494	9.5187	6.00	14.50	0.000
	Final HbA1c	6.098	1.1435	0.1668	5.762	6.434	4.6	8.8	
20-50gm CHO/day	Initial HbA1c	6.3000	0.16330	0.06172	6.1490	6.4510	6.00	6.50	0.000
	Final HbA1c	5.229	0.2215	0.0837	5.024	5.433	5.1	5.7	

Reduction and elimination of medication

Medication reduction or discontinuation is a significant influence that observed in the current study in people who followed the carbohydrate restriction. Table (4) shows a total of (n=37, 26%) individuals in which of 143 individuals discontinued and (n=52, 36%) individuals in which of (n=143) individuals diabetic medication dosage has been reduced upon carbohydrate restriction.

Table 4: Changes in diabetes medications of (n=143) participants with type II diabetes & prediabetes who underwent 3 months of DCP intervention

Patient number	Daily dose- At DCP start	Daily dose - after 3M
Medications discontinued (n=37 of 143 originally on medication)		
3	GALVUSMET 50/500MG TAB	none
17	GLYCOMET SR TAB 500mg	none
7	JALRA TAB 50mg	none
3	JANUMET FILM-COATED TAB	none
6	JARDIANCE 25MG TAB	none
1	TENZULIX M 500MG TAB	none
Medications reduced (n= 52 of 143)		
4	BASAGLAR KWIKPEN 3ML INJ+ glycomet 500mg	GALVUSMET 50/500MG TAB (2), GLYCOMET SR TAB 500mg (2)
5	Fiasp 100 IU/ml Penfill+GLYCOMET SR TAB 500mg	GALVUSMODIFIED-RELEASE TAB 50mg (1), TENZULIX M 500MG TAB (1), GLYCOMET SR TAB 500mg (2), Tab Galvusmet 50/500, Tab zoryl 1mg (1)
5	GALVUSMET 50/500MG TAB	GLYCOMET SR TAB 500mg (4), Tab Teniva 20mg (1)
4	GLYCOMET SR TAB 500mg	JARDIANCE 25MG TAB (2), Tab Teniva 20mg (2)
2	HUMALOG KWIKPEN PRE-FILLED PEN 100IU/1mL+glycomet 500mg	GALVUSMET 50/500MG TAB
2	JALRA TAB 50mg	JARDIANCE 25MG TAB
3	JANUMET 50/1000MG TAB	GLYCOMET SR TAB 500mg (2), JARDIANCE 25MG TAB (1)
2	OBIMET SR TAB 500mg	GLYCOMET SR TAB 500mg (2)
3	Tab Galvusmet 50/500, Tab zoryl 1mg	Tab Galvusmet 50/500 (2), Tab zoryl 1mg (1)
1	Tab Teniva 20mg	JARDIANCE 25MG TAB (1)
11	TENZULIX M 500MG TAB	GALVUSMET 50/500MG TAB (2), GLYCOMET SR TAB 500mg (1), JALRA TAB 50mg (1), JARDIANCE 25MG TAB (6), JARDIANCE 50MG TAB (1)
3	VOLIBO TAB 0.3mg	JARDIANCE 25MG TAB (2), GLYCOMET SR TAB 500mg (1)
1	ZITA MET PLUS 20/500MG TAB	OBIMET SR TAB 500mg
6	ZOMELIS MET 50/1000 MG TABLET	GALVUSMET 50/500MG TAB (4), GLYCOMET SR TAB 500mg (1), JARDIANCE 25MG TAB (1)

Discussion

The present study investigated the efficacy of a digital nutrition therapy provided through diabetes care program (DCP) which is delivered via Mfine application. As part of the continuous monitoring included in the program, DCP emphasizes the significance of sharing meal images and vitals like Fasting blood Sugar levels and Post Prandial Blood Sugar in the application. The participants who were enrolled in the program was from various parts of India were asked to share the meal images daily to track the intake of macro and micronutrients. Participants were given unlimited access to their coaches through the application and via telephone, and on-demand dietician consultations for the entire duration of the program. All participants were asked to share their meal images after getting a customized diet plan from their dietician.

The results of the study (table 1) indicated that the average age of the clients who enrolled for the program was (48.1±12.3) years, and most of the clients were between the age of 27-74 yrs. Which shows the rapid growth of digital technologies [14], which offers improvement in public health, particularly in prevention and health promotion.

The study highlighted that digital Nutrition therapy delivered by DCP was effective in reducing the glycemic levels (HbA1c, FBS, and ABG) of individuals who enrolled and followed program (p-0.000) among diabetic and prediabetic groups (table1&2), where a higher percentage of clients—in particular, prediabetic individuals—have returned to normal levels. These results are in line with those of comparable research that have examined the low carbohydrate diet [15, 17]. and app-based interventions to improve diet, physical activity and sedentary behaviours can be effective [18, 19].

The program clients also reported statistically significant levels on reducing (HbA1c, FBS, and ABG) post program completion (table 2). There is a reduction of 2.48% among diabetes and 1.02% reduction of HbA1c among prediabetes. The overall reduction of HbA1c among total sample (n=172) is found to be 2.19, (p-.000). Hence the Null hypothesis was rejected, and the research hypothesis has been accepted. The effect size for total sample (1.21) was also statistically found to be large indicating a large positive impact of DCP on the overall symptoms of the clients enrolled in the program. These results of our study are

consistent with previous meta-analyses conducted on diet, physical activity and health interventions, which have demonstrated their potential to improve overall health outcomes [20, 23]. Web-based programs and apps are relatively low cost with the potential for broad reach, however sustained engagement is a key factor constraining effectiveness [24]. The use of web-based programs and smartphone apps will continue to proliferate as health information services used by the public [25].

Mfine's Diabetes care program can be highly beneficial to people with T2DM for improving glycemic control. Mfine is a multi-specialty online platform powered by AI that aims to enhance people's overall health and wellness. The application relates to more than 84 different specialties. The Diabetic Care Programme (DCP) is a technology-enabled, individualised programme that brings together a range of specialties such as diabetologists, dietitians, fitness experts, and committed health coaches to help people continuously monitor and support themselves and improve their health by receiving customised advice. By using the BP and heart rate monitor that are already included into the platform, users can use it as a tool to check their state of health. Especially in developing countries like India, virtual access to interdisciplinary field experts can significantly improve patients care.

Further, the program being focused on HbA1c levels as the outcome for lifestyle modification can help in achieving goals in a measured way. The weekly glucose and daily real time meal image monitoring based analysis of the program helped in providing a personalized approach, while the assessment of HbA1c, FBS, ABG levels at the beginning and end helped in understanding the program results in a resource efficient and clinically effective manner.

At the completion of the 3-month programme, the participants' HbA1c levels had significantly decreased by 2.19%. According to clinical research, a 1% decrease in mean HbA1c levels correlates to a 14% decrease in the risk of myocardial infarction, a 21% decrease in the risk of diabetes-related death, and a 37% decrease in the risk of microvascular complications [26]. Another study among Americans with T2DM found that 1% lower HbA1c levels were associated with 2% lower costs for total healthcare due to all causes and 13% lower costs for diabetes-related care [27]. The program was effective in improving glycemic control in participants with different baseline HbA1c levels, 42.4% (73/172) reached the recommended target of HbA1c 6% showed an average HbA1c reduction by 1.7% (SD 1.38) ($P<0.001$).

The participants in our study also showed a significant ($p<0.00$) average reduction in weight by 4.7 kg after 3 months of the program. These results were like those reported in studies on other programs using digital diabetes care for people with T2DM, showing a mean weight reduction by 2.04kg [28, 29].

In most therapeutic settings, a reduction in symptoms together with a reduction in medication is considered as a sign of effectiveness. In the study, of 11 patients on medication in the VLCKD arm who finished the study, 5 reduced or discontinued one medication and 2 discontinued all medications. Of the 13 patients on the moderate carbohydrate diet, only 1 discontinued a sole medication. Similarly, another study found that 17 of 21 patients with type 2 diabetes reduced or discontinued diabetes medication upon carbohydrate restriction [30]. This result is a general feature of carbohydrate restriction in type 2 diabetes [31-34]. In the current study in people who followed the carbohydrate restriction. Table (4) shows a total of (n=37, 26%) individuals in which of 143 individuals discontinued and (n=52, 36%) individuals in which of (n=143) individuals diabetic medication dosage has been reduced upon carbohydrate restriction.

Twelve studies reported medication changes at 3–6 months, and six at 12–24 months. There was a greater reduction in medication use for participants on carbohydrate-restricted diets compared with high carbohydrate diets at every time point. Carbohydrate restriction either reduced the dosage of oral medications and/or insulin or saw an elimination of medication for participants across all studies that reported on medication outcomes [35].

Our results demonstrated that the Mfine Diabetes care program significantly improved glycemic control in participants with various medication histories and that lifestyle modification can be a significant factor in improving glycemic control in participants who are not taking any antidiabetic medications.

Strength and Limitations of the study

This study's strength is its use of a commercial program to analyze data in contexts that are like real-world circumstances. Participants from different ages, states in India, treatment plans, and baseline HbA1c, FBS, ABG, values were included in these preliminary findings of the study. The nonrandomized design, lack of a control group, self-selection bias, and referral bias are all contributed to the study's limitations. The participants' glycemic outcomes after completing the program for 3 months are considered in this study. To fully understand the efficacy of this digital diabetes care program, more research will be needed with a larger sample size, control groups, and longer duration of time periods.

Conclusion

Digital nutrition counselling and monitoring interventions with Mfine application targeting Prediabetes and type II diabetes are effective for improving glycaemic levels (HbA1c, FBS, ABG). There was a significant improvement in their glycaemic levels, as well decreased their body weight and BMI. As demonstrated from the meal image monitoring provided the information about the food consumption which helped to deliver timely suggestions and tailored nutrition therapy that improved the patient outcomes. Thus, this digital therapeutic program can be considered as an effective tool for improving glycaemic control in people with diabetes & Prediabetes individuals.

Acknowledgments

We thank all the participants in this study. We would also like to thank all the Mfine care team.

Abbreviations

BMI: Body mass index; CRDs: Carbohydrate-restricted diets; CRD: Carbohydrate-reduced diet; HbA1c: Haemoglobin A1c; DCP: Diabetes care program; T2DM: Type 2 diabetes; FBS: Fasting blood glucose; ABG: Average blood glucose.

Author Contributions

Bhagyasri A. Goud & Dr Raja Indana contributed to the conception and design of the study. Bhagyasri A. Goud, Dr Raja Indana, Bhawi, and Mrudula Duggani contributed to the acquisition of data. Bhagyasri A. Goud, Dr Raja Indana and Balakrishna Nagalla made analysis, and interpretation of data. Bhagyasri A. Goud, Dr Raja Indana, Mekha U Prabhu and Swati Kaktikar drafted the manuscript. Bhagyasri A. Goud, Dr Raja Indana, Bhawi, Mrudula Duggani, Balakrishna Nagalla, Mekha U Prabhu and Swati Kaktikar critically revised the manuscript. All the authors gave final approval. All authors revised the manuscript and agreed to be fully accountable for ensuring the integrity and accuracy of the work, read and approved the final manuscript.

Conflict of Interest

None declared. The authors declare that they have no competing interests.

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