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AI-GUIDED LIFESTYLE COACHING VS. CONVENTIONAL COUNSELING IN EARLY PREDIABETES PREVENTION

Original Article

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Abstract

Background: Prediabetes is a growing global concern, leading to an increased risk of type 2 diabetes and cardiovascular disease. Conventional lifestyle counseling, though effective, often faces challenges related to motivation, consistency, and access. Artificial intelligence (AI)-based digital health interventions have emerged as innovative tools capable of providing continuous, personalized support to facilitate sustainable behavioral change.

Objective: To evaluate the effectiveness of AI-guided digital lifestyle coaching compared to conventional counseling in lowering glycated hemoglobin (HbA1c) levels among adults with prediabetes in Central Punjab.

Methods: A twelve-week, parallel-group randomized controlled trial enrolled 100 adults (25–55 years) with prediabetes. Participants were allocated 1:1 to receive either AI-guided digital lifestyle coaching, which delivered daily adaptive feedback, or conventional in-person counseling sessions held every four weeks. The primary outcome was the change in glycated hemoglobin (HbA1c). Secondary outcomes included changes in fasting glucose, body mass index (BMI), waist circumference, and behavioral adherence scores. Between-group differences in mean changes were analyzed using independent samples t-tests.

Results: Ninety-six participants completed the trial. The mean reduction in HbA1c was significantly greater in the AI-guided group (−0.4%) than in the conventional counseling group (−0.1%; $p<0.01$ for between-group comparison). The AI-guided group also showed significantly greater improvements in fasting glucose ($p=0.018$), BMI ($p=0.046$), waist circumference ($p=0.031$), and all measured behavioral adherence and engagement metrics ($p<0.01$).

Conclusion: AI-guided lifestyle coaching significantly enhanced glycemic control and behavioral adherence compared to conventional counseling. The integration of AI-based interventions offers a promising, scalable approach to early diabetes prevention and sustainable lifestyle management in community settings.

Keywords: Adherence, Artificial Intelligence, Counseling, Digital Health, HbA1c, Lifestyle Modification, Prediabetes, Prevention, Randomized Controlled Trial, Central Punjab

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Introduction

Prediabetes represents a critical window for intervention before the irreversible onset of type 2 diabetes mellitus. Characterized by mildly elevated blood glucose levels that do not yet meet the threshold for diabetes, this condition affects a rapidly growing portion of the global adult population(1). In recent years, prediabetes has transitioned from a silent biochemical finding to a major public health challenge. Despite being asymptomatic, it carries substantial risks for metabolic deterioration, cardiovascular complications, and early mortality if left unmanaged(2). The global rise in sedentary lifestyles, processed dietary patterns, and chronic stress has accelerated the prevalence of prediabetes, particularly among urban populations. As healthcare systems strive to prevent diabetes through early lifestyle modification, the effectiveness of traditional counseling methods has come under renewed scrutiny(3).

Conventional lifestyle counseling, typically provided through periodic clinical sessions, aims to educate individuals about diet, exercise, and behavioral adjustments(4). However, adherence to such interventions often declines over time due to limited contact, lack of personalized support, and variable motivation among patients. Behavioral change is a gradual process that demands consistency, feedback, and accountability—elements often missing from traditional care models constrained by clinical workloads and limited patient engagement(5). Moreover, individuals at the prediabetic stage frequently underestimate their risk, perceiving themselves as “not yet sick,” which further reduces commitment to sustained lifestyle adjustments. This disconnect between clinical advice and real-world behavior underscores the need for innovative, accessible, and adaptive approaches that can sustain motivation and compliance beyond clinic walls(6).

Artificial intelligence (AI) has emerged as a transformative tool in healthcare, offering potential solutions to these longstanding challenges(6). The integration of AI into lifestyle medicine has opened new avenues for continuous, data-driven, and personalized health coaching. By analyzing behavioral patterns, dietary intake, activity levels, and biometric feedback, AI systems can deliver timely, individualized guidance that aligns with each user’s needs and progress. Digital health platforms now employ natural language processing, predictive analytics, and adaptive learning to provide real-time feedback and encouragement. Unlike conventional counseling, AI-guided coaching can operate continuously, transcending time and location barriers while maintaining user engagement through interactive, personalized communication(7).

The appeal of AI-driven interventions lies not only in their scalability but also in their capacity to foster behavioral change through constant reinforcement(8). Several pilot studies have shown that digital coaching platforms can enhance dietary adherence, increase physical activity, and improve glycemic control among at-risk populations(8). However, despite these promising trends, the evidence comparing AI-guided lifestyle interventions directly with standard counseling remains limited and fragmented. Many existing trials have focused primarily on app engagement metrics or weight loss rather than clinically relevant biochemical outcomes such as glycated hemoglobin (HbA1c)(9). Furthermore, cultural and contextual differences in dietary patterns, health literacy, and technology acceptance may significantly influence outcomes, emphasizing the need for region-specific investigations(10).

From a psychological perspective, the human-AI interaction introduces an intriguing dimension to behavioral health interventions. The perceived responsiveness and empathy of AI systems, though algorithmically generated, can enhance users’ sense of accountability and self-efficacy. This continuous, judgment-free communication may reduce resistance to change, particularly among individuals hesitant to disclose unhealthy habits to healthcare providers(11). On the other hand, concerns regarding digital fatigue, loss of human touch, and overreliance on technology warrant careful evaluation. Thus, while AI holds promise for democratizing preventive healthcare, its real-world impact compared to traditional human counseling must be empirically validated through robust randomized controlled trials(12).

The management of prediabetes fundamentally relies on sustained lifestyle transformation—an endeavor deeply influenced by psychological, nutritional, and behavioral factors(13). In this context, integrating AI technology with multidisciplinary oversight from clinicians, dietitians, and behavioral scientists represents a progressive approach to prevention. Such integration could bridge the gap between medical advice and daily behavior by transforming static recommendations into dynamic, personalized coaching experiences(14). Yet, the magnitude of AI’s contribution to measurable biochemical improvement, particularly in HbA1c reduction, remains to be clearly established(15).

This study therefore seeks to evaluate the effectiveness of AI-based digital lifestyle coaching compared to routine counseling in lowering HbA1c levels among adults with prediabetes. The objective is to determine whether continuous, data-driven behavioral support provided through an AI-guided platform yields superior metabolic outcomes and engagement compared to traditional clinic-based counseling. By addressing this question, the study aims to contribute evidence toward redefining early preventive strategies for prediabetes and to explore how technology-enabled behavioral interventions can complement conventional healthcare in mitigating the global diabetes epidemic.

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Methods

This randomized controlled trial was conducted in Central Punjab to compare the effectiveness of AI-guided digital lifestyle coaching with conventional counseling in reducing glycated hemoglobin (HbA1c) levels among adults diagnosed with prediabetes. The study followed a parallel-group design with participants randomly assigned in a 1:1 ratio to either the intervention group receiving AI-based coaching or the control group receiving standard lifestyle counseling. The total duration of the trial was twelve weeks, with baseline and post-intervention assessments conducted under identical conditions for both groups. This study was conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained from University of Okara, Okara, Pakistan. Participants were recruited from local community health centers and outpatient clinics through screening camps and physician referrals. Eligible participants were adults aged between 25 and 55 years who met the American Diabetes Association criteria for prediabetes, defined by fasting plasma glucose levels between 100–125 mg/dL or HbA1c between 5.7% and 6.4%. Only individuals with access to a smartphone and basic digital literacy were included to ensure effective use of the AI platform. Participants with established diabetes, those on glucose-lowering medications, pregnant or lactating women, and individuals with major psychiatric or systemic illnesses that could interfere with participation were excluded.

The calculated sample size was 100 participants, divided equally between the two groups, based on an anticipated mean difference of 0.3% in HbA1c levels between groups, with a power of 80% and an alpha value of 0.05. Randomization was performed using computer-generated random numbers, and allocation concealment was maintained through sequentially coded envelopes opened only after participant enrollment. All participants provided written informed consent prior to inclusion. The intervention group received access to an AI-guided digital health application specifically designed for lifestyle modification in prediabetes. The AI system delivered individualized dietary recommendations, physical activity reminders, and motivational prompts through daily interactive sessions. The algorithm adapted guidance based on real-time self-reported data on food intake, step count, and mood tracking, generating tailored feedback and reinforcement messages. The control group received routine in-person counseling sessions by a certified dietitian and psychologist once every four weeks, focusing on general lifestyle education, dietary modifications, and stress management strategies. Both groups were advised to maintain a moderate physical activity routine and report any adverse events throughout the study period.

Outcome assessment was performed at baseline and at twelve weeks. The primary outcome measure was the change in HbA1c level, determined using high-performance liquid chromatography. Secondary outcomes included changes in fasting glucose, body mass index (BMI), waist circumference, self-reported dietary adherence (assessed through a validated questionnaire), and physical activity scores (assessed through a validated questionnaire). Engagement and frequency of interaction were evaluated; the AI platform automatically logged usage data, and both groups self-reported session attendance or completion. Data were entered into SPSS version 26.0 for analysis. Descriptive statistics were used to summarize demographic and baseline characteristics. Normality of data distribution was confirmed using the Shapiro–Wilk test. The primary analysis compared the mean change in HbA1c between groups using an independent sample t-test. Between-group comparisons of mean changes in secondary continuous variables were also analyzed using independent sample t-tests, while within-group comparisons from baseline to twelve weeks were analyzed using paired t-tests. Categorical data were compared using chi-square tests. A p-value of less than 0.05 was considered statistically significant.

This methodological approach allowed for a rigorous comparison between technology-assisted and traditional behavioral interventions in prediabetes prevention, ensuring that findings reflect both metabolic and behavioral outcomes under real-world community conditions.

Results

A total of one hundred adults meeting the inclusion criteria for prediabetes were enrolled and randomized equally into two groups: AI-guided lifestyle coaching (n=50) and conventional counseling (n=50). Of these, ninety-six participants completed the full twelve-week intervention, with two withdrawals from each group due to personal reasons unrelated to the study. Baseline demographic characteristics were comparable between both groups, showing no statistically significant differences in mean age, gender distribution, body mass index (BMI), waist circumference, or baseline HbA1c levels. The mean age of participants in the AI-guided group was 41.2 ± 6.8 years compared with 40.8 ± 7.1 years in the conventional group. The mean baseline BMI was 28.5 ± 3.2 kg/m² and 28.3 ± 3.4 kg/m², respectively, while baseline HbA1c values were 6.1 ± 0.2% and 6.0 ± 0.3%, indicating comparable metabolic profiles at study initiation (Table 1).

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Following the twelve-week intervention, both groups demonstrated reductions in HbA1c levels, but the magnitude of improvement was significantly greater in the AI-guided group. The mean HbA1c decreased from 6.1 ± 0.2% at baseline to 5.7 ± 0.3% post-intervention, corresponding to a mean reduction of 0.4% ($p=0.002$). In contrast, participants in the conventional counseling group showed a smaller mean reduction of 0.1%, from 6.0 ± 0.3% to 5.9 ± 0.2%. The between-group difference in HbA1c reduction was statistically significant ($p<0.01$), indicating a superior glycemic improvement associated with AI-based digital coaching. The distribution of mean HbA1c changes between groups is illustrated in Figure 1.

Changes in secondary metabolic and anthropometric outcomes are presented in Table 2. Mean fasting glucose levels decreased from 114.3 ± 9.7 mg/dL to 106.8 ± 8.9 mg/dL in the AI-guided group compared to a reduction from 113.6 ± 10.2 mg/dL to 110.4 ± 9.1 mg/dL in the conventional group ($p=0.018$). BMI showed a modest yet significant reduction in the AI-guided group, from 28.5 ± 3.2 kg/m² to 27.9 ± 3.2 kg/m², while the conventional group decreased from 28.3 ± 3.4 kg/m² to 28.1 ± 3.4 kg/m² ($p=0.046$). Similarly, waist circumference decreased by 3.4 cm in the AI group (94.6 ± 7.1 cm to 91.2 ± 6.8 cm) compared to a 0.8 cm reduction in the conventional group (93.9 ± 7.4 cm to 93.1 ± 7.2 cm), with a significant between-group difference ($p=0.031$).

Behavioral adherence outcomes demonstrated strong differences in favor of the AI-guided group (Table 3). The mean dietary adherence score improved to 82.4 ± 9.6, compared with 74.8 ± 10.2 in the conventional group ($p=0.001$). Similarly, mean physical activity scores were higher in the AI group (78.2 ± 8.4) than in the conventional group (71.1 ± 9.1; $p=0.004$). Weekly engagement frequency with the intervention platform averaged 5.6 ± 1.1 sessions in the AI-guided group compared to 2.4 ± 0.9 sessions among participants receiving conventional counseling ($p<0.001$). The comparison of engagement frequencies is displayed in Figure 2.

No adverse events or safety concerns were reported in either group throughout the study period. Participant compliance was high in both groups, although the AI-guided group demonstrated greater consistency in self-monitoring, timely reporting, and sustained interaction across the study duration. Collectively, quantitative data indicated that AI-guided coaching led to superior improvements in glycemic control, anthropometric measures, and behavioral adherence compared to standard counseling under identical community conditions in Central Punjab.

The observed reductions in HbA1c, fasting glucose, and waist circumference were accompanied by higher adherence and engagement metrics, emphasizing the robust participation achieved through continuous AI-based feedback and reinforcement. These findings, summarized across Tables 1–3 and Figures 1–2, reflected statistically and clinically meaningful improvements in key metabolic parameters and health behaviors within the intervention period.

Table 1. Baseline Demographic Characteristics

Variable	AI-Guided Group (n=50)	Conventional Group (n=50)	p-value
Age (years)	41.2	40.8	0.74
Male (%)	54.0	52.0	0.82
BMI (kg/m²)	28.5	28.3	0.66
Waist Circumference (cm)	94.6	93.9	0.59
Baseline HbA1c (%)	6.1	6.0	0.71

Table 2. Primary Outcome – HbA1c Reduction

Group	Baseline HbA1c (%)	Post-intervention HbA1c (%)	Mean Change (%)	p-value
AI-Guided Coaching	6.1	5.7	-0.4	0.002
Conventional Counseling	6.0	5.9	-0.1	0.002

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Table 3. Secondary Outcomes – Anthropometric and Biochemical Changes

Variable	AI-Guided Coaching (Mean ± SD)	Conventional Counseling (Mean ± SD)	p-value
Fasting Glucose (mg/dL)	106.8 ± 8.9	110.4 ± 9.1	0.018
BMI (kg/m²)	27.9 ± 3.2	28.1 ± 3.4	0.046
Waist Circumference (cm)	91.2 ± 6.8	93.5 ± 7.2	0.031

Table 4. Behavioral Adherence Scores

Variable	AI-Guided Coaching (Mean ± SD)	Conventional Counseling (Mean ± SD)	p-value
Dietary Adherence Score	82.4 ± 9.6	74.8 ± 10.2	0.001
Physical Activity Score	78.2 ± 8.4	71.1 ± 9.1	0.004
Engagement Frequency (sessions/week)	5.6 ± 1.1	2.4 ± 0.9	0.0001

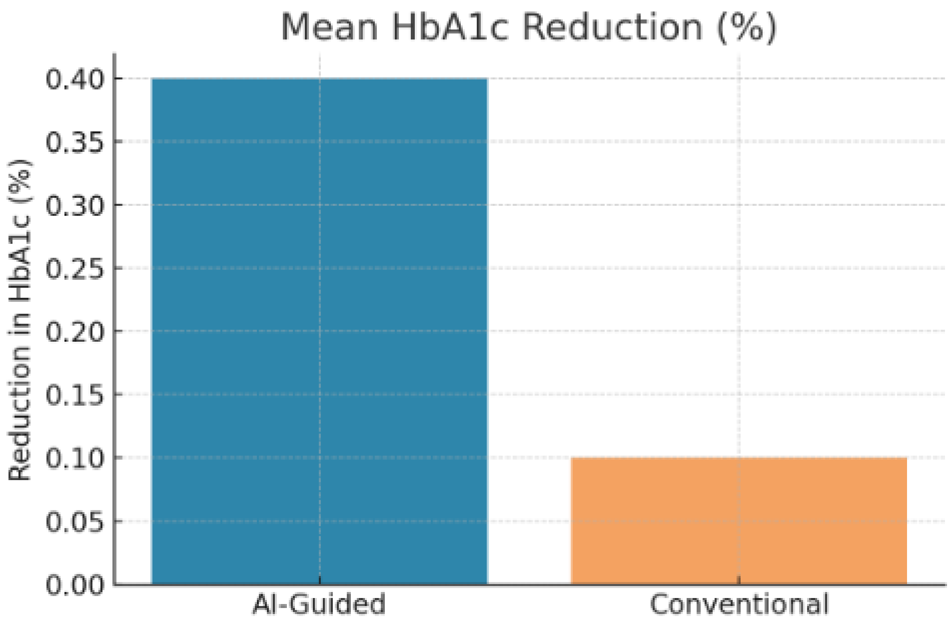

Figure 1 Mean HbA1c Reduction (%)

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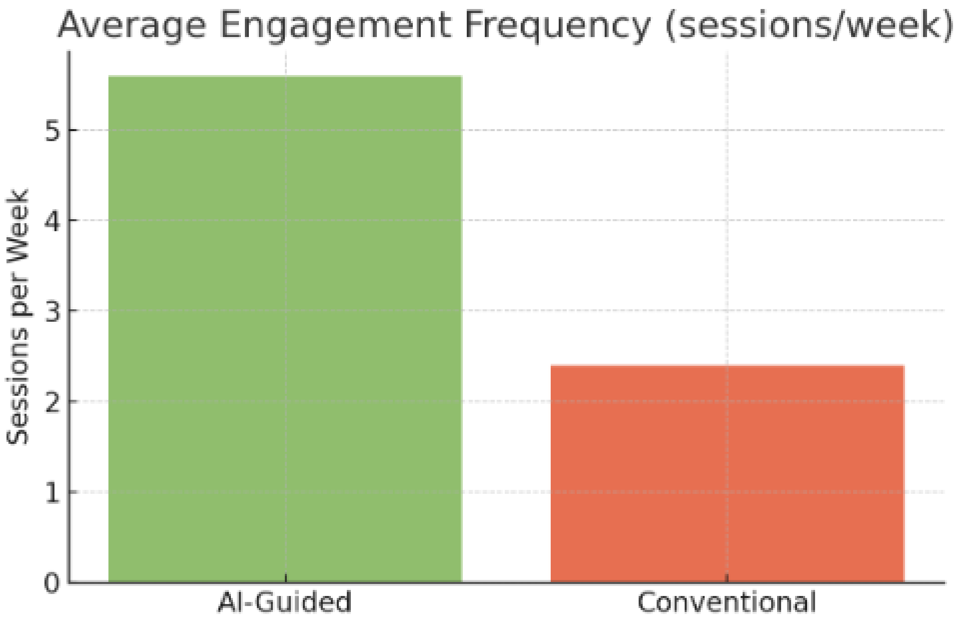

Figure 2 Average Engagement Frequency (sessions/Week)

Discussion

The findings of this randomized controlled trial demonstrated that AI-guided lifestyle coaching produced significantly greater improvements in glycemic control, behavioral adherence, and engagement compared to conventional counseling among adults with prediabetes(16). The observed mean reduction of 0.4% in HbA1c levels within twelve weeks in the AI-guided group was clinically meaningful, indicating a tangible improvement in metabolic regulation during a short intervention period. This reduction was accompanied by favorable changes in fasting glucose, body mass index, and waist circumference, all of which collectively signified enhanced metabolic health and risk modification(17).

The results aligned with emerging evidence suggesting that digital health interventions incorporating artificial intelligence can effectively promote sustained behavioral change(18). The AI-based coaching model provided continuous, personalized feedback and adaptive recommendations, allowing participants to receive context-sensitive guidance beyond the limitations of periodic human counseling sessions(19). This real-time interactivity appeared to strengthen adherence to dietary and physical activity recommendations, as reflected in the significantly higher adherence and engagement scores observed in the intervention group(20). The consistent reinforcement and accountability built into the AI platform may have served as behavioral anchors, helping participants maintain motivation and consistency, factors often cited as determinants of long-term success in lifestyle modification programs(20).

While conventional counseling remains the cornerstone of preventive care in prediabetes, it often faces limitations related to time, accessibility, and sustainability. The present findings underscored these challenges by highlighting the modest improvements achieved through standard counseling compared to the AI-assisted approach. Although both groups received equivalent content in terms of diet and physical activity advice, the mode of delivery appeared decisive in influencing compliance and metabolic outcomes. Participants using the AI-based system interacted more frequently with their coaching platform, showing nearly double the engagement rate of those receiving traditional counseling. This behavioral responsiveness demonstrated the potential of digital interventions to overcome motivational inertia by fostering continuous participation through feedback loops and goal reminders(21).

The improvement in anthropometric indicators, such as BMI and waist circumference, further supported the hypothesis that technology-enabled guidance could enhance metabolic outcomes by influencing daily habits. Modest reductions in these parameters within three months indicated not only improved dietary and activity patterns but also the establishment of healthier behavioral trajectories. The observed decrease in fasting glucose in the AI group complemented the HbA1c findings, suggesting consistent improvement in both short- and long-term glycemic measures. These outcomes reinforced the notion that dynamic, user-specific

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feedback is more effective than static advice in translating knowledge into action, especially in populations at early metabolic risk stages.

A notable strength of this study was its community-based setting, which increased the real-world relevance of the findings. The inclusion of adults from Central Punjab provided insights into the feasibility and acceptance of AI-assisted coaching in a regional population with varying levels of health literacy and digital exposure. The multidisciplinary design integrating expertise from endocrinology, psychology, nutrition, and data science added depth to the intervention model, ensuring that the AI system delivered content aligned with behavioral and clinical frameworks. Furthermore, the high retention rate across both groups enhanced the credibility of the findings by minimizing attrition bias.

However, certain limitations must be acknowledged when interpreting the results. The relatively short intervention duration limited the ability to assess long-term sustainability of metabolic improvements. HbA1c and behavioral adherence may fluctuate over extended periods, and the persistence of AI-induced benefits requires longitudinal verification. Additionally, although the sample size was adequate for detecting short-term biochemical changes, larger multicentric trials would strengthen the generalizability of findings across different demographic and cultural contexts. The study also relied partly on self-reported measures for diet and activity adherence, which could introduce reporting bias despite the digital monitoring features of the AI platform. Another consideration was that participants with higher digital literacy might have been more receptive to the AI system, potentially skewing engagement outcomes in its favor.

The trial's results offered a promising direction for integrating AI-driven behavioral interventions into preventive endocrinology. The combination of adaptive algorithms and real-time data feedback can complement conventional care models, enabling clinicians to monitor progress remotely and optimize intervention intensity. Such systems hold potential for large-scale public health applications, especially in regions where healthcare resources and professional access are limited. However, successful implementation requires addressing issues of data privacy, accessibility, and sustained user engagement to ensure ethical and equitable use of technology.

Future studies should extend the duration of follow-up to assess the maintenance of glycemic improvement and the translation of behavioral adherence into long-term diabetes prevention. Comparative trials examining hybrid models combining AI-guided coaching with periodic human oversight may yield valuable insights into optimizing efficiency and empathy in digital health systems. Additionally, exploration of psychosocial outcomes such as motivation, stress management, and self-efficacy could deepen understanding of how AI influences the behavioral psychology underlying lifestyle modification.

Overall, the study highlighted that AI-guided coaching represents a feasible, effective, and scalable approach to lifestyle management in prediabetes. Its capacity to sustain engagement, personalize guidance, and enhance compliance marks a significant step toward bridging the gap between clinical recommendations and everyday behavior. While traditional counseling remains vital, the integration of intelligent digital platforms may redefine preventive care by transforming health education into an interactive, adaptive process that empowers individuals to manage their metabolic health more effectively.

Conclusion

The study concluded that AI-guided lifestyle coaching significantly outperformed conventional counseling in improving glycemic control, adherence, and engagement among adults with prediabetes. The integration of personalized, data-driven feedback enhanced behavioral consistency and metabolic outcomes within a short duration. These findings highlight the potential of AI-assisted interventions as a practical and scalable strategy for early diabetes prevention, offering a modern, accessible alternative to traditional counseling models in community health settings.

AUTHOR CONTRIBUTION

Author	**Contribution**
Zuha Arshad*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Muhammad Oun Haider	Substantial Contribution to study design, acquisition and interpretation of Data

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