Effectiveness of Lifestyle Score Calculator in Improving Diabetes Management Using BeatO Application

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Abstract

India has around 101 million people living with diabetes and another 136 million in the prediabetes stage with a significant majority remaining undiagnosed. Lifestyle factors, such as insufficient physical activity, sedentary behavior, and poor dietary patterns, contribute to the development of type 2 diabetes. Innovative solutions are needed to aid patients in effectively managing their health. The study aimed to evaluate the efficacy of the Lifestyle Score Calculator, integrated into the BeatO mobile application, in promoting positive lifestyle changes among individuals managing diabetes. The study included 908 active users with diabetes who used the BeatO application for lifestyle score assessments at least four times between August 1, 2023, and January 30, 2024. In their initial assessment, 21% of patients were classified as having low lifestyle scores, 51% as medium, and 29% as high. Transition analysis revealed significant improvements over time, with 83% of patients initially categorized with a low lifestyle score successfully moving up to higher categories. Category-specific analysis showed notable improvements in eating and drinking habits, physical activity levels, blood glucose management, and medication adherence. The findings demonstrate the effectiveness of the Lifestyle Score Calculator in fostering positive transitions across lifestyle categories, particularly among those with initially lower scores. These results affirm the potential of personalized interventions based on lifestyle scores to facilitate sustained positive lifestyle changes among individuals managing diabetes. Further research and continuous monitoring are needed to understand the long-term impact of these interventions and refine personalized diabetes management strategies.

Keywords: diabetes, mobile health applications, lifestyle score calculator, blood glucose levels, body mass index, personalized healthcare

Abbreviations: NNMS: National Noncommunicable Disease Monitoring Survey; DPP: Diabetes Prevention Program; DPS: Diabetes Prevention Study; DA Qing Study: Da Qing Diabetes Prevention Study; B2C: business-to-consumer; BSL: blood glucose levels; BMI: body mass index; ILI: intensive lifestyle intervention; DSE: Diabetes Support and Education

Introduction

Lifestyle-related diseases like type 2 diabetes pose growing health concerns. Despite the effectiveness of structured lifestyle support, it is currently available to less than ten percent of patients due to practical and financial barriers [1, 2]. Based on the National Noncommunicable Disease Monitoring Survey (NNMS), the prevalence of diabetes mellitus was 9.3%, while impaired fasting blood glucose was 24.5% [3]. The development of type 2 diabetes is linked to an unhealthy lifestyle, including insufficient physical activity, sedentary behavior, and poor dietary patterns [4].

A recent study on physical activity found that a substantial portion of the Indian population is either physically inactive or engages in only mild activity. Additionally, the study observed that females are less physically active than males. A study on the association between abdominal obesity and diabetes showed about half of the male population and three-fifths of the female population had abdominal obesity. The prevalence of diabetes was 8.65% among males and 7.39% among females, indicating a slightly higher burden of the disease among males [5].

Multiple key randomized controlled trials, including the Diabetes Prevention Program (DPP) trial, the Finnish Diabetes Prevention Study (DPS), and the Da Qing Diabetes Prevention Study (DA Qing Study), have demonstrated the high effectiveness of lifestyle/behavioral intervention involving personalized reduced-calories meal plans in preventing or delaying the onset of type 2 diabetes. These interventions have also been found to improve other cardiometabolic risk factors, such as blood pressure, lipids, and inflammation [6].

Self-management of diabetes can be challenging due to limited training, difficulties in sustaining lifestyle changes, and limited access to specialized healthcare. The advancement of mobile technology has led to the creation of numerous health-related smartphone applications aimed at improving patients' self-management skills in chronic disease, facilitating communication with healthcare providers, and enhancing patient compliance with treatment [7]. There is limited evidence on the effectiveness of digital health applications in lifestyle management. This gap needs to be addressed to implement mobile applications for lifestyle interventions in people with diabetes.

The BeatO mobile application is designed as a business-to-consumer (B2C) product and is considered a valuable tool for individuals managing diabetes. Beyond conventional health metrics monitoring, such as blood glucose levels (BSL), body mass index (BMI), and physical activity, BeatO provides personalized insights based on BSL, facilitates communication with health coaches and doctors, and offers access to diabetes-friendly products.

This study aimed to evaluate the efficacy of the Lifestyle Score Calculator, integrated within the BeatO mobile application, in promoting positive lifestyle changes among individuals managing diabetes. The Lifestyle Score Calculator seeks to transcend the limitations of conventional health metrics by conducting a holistic evaluation of patients' daily habits. Unlike conventional methods that rely on medical devices, the Lifestyle Score Calculator uses a questionnaire-based approach to assess users' daily habits on a scale of 0-100. The hypothesis underlying this approach suggests that individuals receiving a low lifestyle score would be more inclined to adhere to the app's recommendations, leading to an improvement in lifestyle and effective diabetes management without reliance on medical devices.

Methods

The study included 908 active users with diabetes who used the BeatO app for lifestyle score assessments at least four times between August 1, 2023, and January 30, 2024. Inactive users or those unable or unwilling to use the BeatO app were excluded to maintain the study's integrity.

We did not seek ethical approval for this study, as it involved a retrospective analysis of outcomes for a large cohort of patients conducted internally as part of an evaluation to improve our quality of care.

The Lifestyle Score is derived from responses to questions across distinct categories, each assigned a specific weight. The categories and associated questions include:

Diet (Weight: 40):

- Portion (Weight: 10): Frequency of overeating in the past 24 h.
- Desserts (Weight: 10): Number of servings of desserts/sweets consumed in the last 24 h.
- Outside food (Weight: 3.33): Quantity of outside meals consumed in the last 24 h.
- Food timings (Weight: 3.33): Timing of the patient's last dinner.
- Hydration (Weight: 3.33): Litres of water consumed in the last 24 h.
- Snacking/munching (Weight: 3.33): Frequency of snacking in the last 24 h.
- Coffee/tea (Weight: 3.33): Cups of tea/coffee consumed in the last 24 h.
- Soft drinks (Weight: 3.33): Glasses of soft drinks consumed in the last 24 h.

Physicals (Weight: 30):

- Alcohol (Weight: 5): Amount of alcohol consumed in the last 24 h.
- Smoking (Weight: 5): Number of cigarettes consumed in the last 24 h.
- Steps (Weight: 10): Number of steps walked in the last 24 h.
- Sitting (Weight: 10): Duration of sitting for more than 60 min in the past 24 h.

Blood glucose (Weight: 10):

- Last blood glucose value (Weight: 10): Status of the patient's last recorded blood glucose value in the last 24 h.

Medication adherence (Weight: 20):

- Adherence to medication (Weight: 20): Whether the patient took all prescribed medicines on time in the last 24 h.

Responses to each question are rated on a scale of 0, 0.5, and 1, then multiplied by the weight associated. The sum of these values provides the overall Lifestyle Score. Depending on the score obtained, personalized messages are sent to patients to provide tailored guidance on how to improve their lifestyle. This approach aims to support individuals in managing diabetes by offering targeted recommendations on diet, habits, blood glucose, and adherence to medications.

Results

Out of the total number of users, 908 active users with diabetes were part of the study. These active users underwent lifestyle score assessment using the BeatO app on at least four occasions between August 1, 2023, and January 30, 2024. In their initial assessment, 21% of patients were classified as having low lifestyle scores, 51% as medium, and 29% as high.

Transition analysis

- Low lifestyle score category

After completing four or more assessments, 83% of patients initially categorized with a low lifestyle score successfully moved up to either medium or high lifestyle score categories. Within this group: 45% progressed from a low to a medium lifestyle score category and 39% advanced from a low to a high lifestyle score category.

▪ Medium lifestyle score category

Among patients initially classified with a medium lifestyle score, 51% were able to elevate their score to the high lifestyle category. Concurrently, 41% maintained a consistent medium lifestyle score category.

▪ High lifestyle score category

Among patients who were initially in the high lifestyle score category, an impressive 79% were successful in maintaining this high lifestyle category throughout the study period (Table 1).

Initial score category	Last known score category			Total
	Low	Medium	High	
Low	31	84	72	187
Medium	33	191	237	461
High	9	46	205	260

Table 1: Number of patients categorized by initial score category and last known score category.

The lifestyle score changed by an average of 8 points for all users.

▪ Low lifestyle score category

After four or more assessments, 83% of patients with initially low lifestyle scores increased their scores by 19 points to reach a medium category score and by 39 points to reach a high category score. On average, these users increased their lifestyle score by 24 points overall.

▪ Medium lifestyle score category

Among patients initially classified with a medium lifestyle score, 51% were able to elevate their score by 15 points. On average, these users increased their lifestyle score by 7 points overall (Table 2).

Initial score category	Last known score category			Average change
	Low	Medium	High	
Low	4	19	39	24
Medium	-21	2	15	7
High	-50	-12	3	-2

Table 2: Average change in lifestyle score categorized by initial score category and last known score category.

Out of the 3 categories based on which lifestyle score is calculated

Category 1: eating and drinking habits

▪ Low lifestyle score category

On average, these users reported an 8-point increase (out of 40) in eating and drinking habits. Patients who moved from the low to medium score category reported a 6-point increase (out of 40) on average. Those who moved from the low to the high score category reported a 12-point increase (out of 40) on average.

▪ Medium lifestyle score category

On average, these users reported a 3-point increase (out of 40) in eating and drinking habits. Patients who moved from the medium to the high score category reported a 6-point increase (out of 40) on average (Table 3).

Initial score category	Last known score category			Average change
	Low	**Medium**	**High**	
Low	2	6	12	8
Medium	-6	2	6	3
High	-16	-3	1	0

Table 3: Average change in eating habits score categorized by initial score category and last known score category.

Category 2: physical and drinking/smoking habits

- Low lifestyle score category

On average, these users reported a 5-point increase (out of 40) in physical and drinking/smoking habits. Patients who moved from the low to medium score category reported a 4-point increase (out of 40) on average. Patients who moved from the low to the high score category reported a 9-point increase (out of 40) on average.

- Medium lifestyle score category

On average, these users reported a 3-point increase (out of 40) in physical and drinking/smoking habits. Patients who moved from the medium to the high score category reported a 6-point increase (out of 40) on average (Table 4).

Initial score category	Last known score category			Average change
	Low	**Medium**	**High**	
Low	1	4	9	5
Medium	-3	1	6	3
High	-17	-5	1	0

Table 4: Average change in physical and drinking/smoking habits score categorized by initial score category and last known score category.

Category 3: blood glucose and medicine adherence

- Low lifestyle score category

On average, these users reported a 9-point increase (out of 40) in blood glucose and medication adherence. Patients who moved from the low to medium score category reported an 8-point increase (out of 40) on average. Patients who moved from the low to the high score category reported a 15-point increase (out of 40) on average.

- Medium lifestyle score category

On average, these users reported no changes in blood glucose and medication adherence. Patients who moved from the medium to the high score category reported a 3-point increase (out of 40) on average (Table 5).

Initial score category	Last known score category			Average change
	Low	**Medium**	**High**	
Low	0	8	15	9
Medium	-11	-1	3	0
High	-13	-6	-1	-2

Table 5: Average change in blood glucose and medicine adherence score categorized by initial score category and last known score category.

The results provide valuable insights into the efficacy of the Lifestyle Score Calculator as a tool for fostering positive lifestyle changes among individuals managing diabetes. The implications of these findings are discussed in the context of advancing personalized and holistic approaches to diabetes management.

Discussion

The study aimed to assess the effectiveness of the Lifestyle Score Calculator, integrated into the BeatO mobile application, in promoting positive lifestyle changes among individuals managing diabetes.

Effectiveness of the lifestyle score calculator

The results demonstrate the efficacy of the Lifestyle Score Calculator in fostering positive transitions across lifestyle categories. Patients with initially low lifestyle scores showed significant improvements over time, with a majority transitioning to higher categories. This indicates that the Lifestyle Score Calculator effectively motivates users to make positive lifestyle changes, leading to improved overall health outcomes.

The D'LITE study showed that smartphone-based lifestyle intervention leads to significant weight loss in Asian adults with type 2 diabetes [8]. A pilot randomized control study demonstrated that a mindfulness-based mobile application led to an increase in restrained eating behavior [9].

Category-specific analysis

The category-specific analysis provides detailed insights into the areas where users showed the most improvement. Eating and drinking habits, physical activity levels, blood glucose management, and medication adherence were the key focus areas. Users with initially low lifestyle scores showed the most significant improvements, with the majority transitioning to higher lifestyle score categories over the study period. The findings suggest that the Lifestyle Score Calculator effectively motivates users to make positive lifestyle changes, leading to improved overall health outcomes.

Potential for personalized interventions

The study highlights the potential of personalized interventions based on lifestyle scores. By tailoring recommendations to individual users' needs and habits, the Lifestyle Score Calculator can effectively address specific areas for improvement. This personalized approach is essential for long-term behavior change and can significantly contribute to better diabetes management outcomes.

Delivering personalized behavioral lifestyle intervention programs to a specified population in a clinic or hospital setting can be challenging and may necessitate the allocation of both healthcare and non-healthcare resources. In the Look AHEAD study, the average cumulative intervention costs were $11,275 per person for intensive lifestyle intervention (ILI) and $887 for Diabetes Support and Education (DSE), while the average cumulative healthcare expenditures were $64,453 for ILI and $68,174 for DSE over the 9 years study period [10].

Implementing lifestyle intervention through mobile applications offers numerous advantages over traditional methods. It addresses common participation barriers such as scheduling, transportation, weather, and childcare, making it more accessible for individuals. The cost-effectiveness of using mobile applications as a lifestyle intervention is high, as it requires no additional financial investments. Since most patients already have smartphones, they only need to download the app from the Apple App Store (iOS Operating System) or Google Play Store (Android Operating System), depending on their phone type.

Gamification in promoting positive lifestyle changes

The integration of gamification elements into the Lifestyle Score Calculator represents a novel approach to fostering user engagement and encouraging positive lifestyle modifications among individuals managing diabetes. By utilizing strategies common in game design, such as social proofing, loss and avoidance, educational feedback, and social sharing, we have observed significant improvements in user behavior and lifestyle choices. This section details how these elements were implemented and their impact on user outcomes.

- Social proofing

The first gamification strategy employed was social proofing. Upon receiving their Lifestyle Score, users were informed of their ranking relative to other users of the BeatO mobile application. This comparative insight provided a tangible perspective on their standing, making the score more relatable and actionable. By understanding where they fit within a broader community, individuals were more motivated to improve their scores, fostering a healthy competitive spirit that encouraged positive lifestyle changes.

- Loss and avoidance

Another critical element was the concept of loss and avoidance. Users classified within the high category were awarded a green streak, symbolizing their achievement in maintaining healthy lifestyle choices. We found that users who had established a streak were more determined to sustain their positive behaviors to avoid losing their status. This element of gamification effectively tapped into the users' aversion to loss, motivating them to consistently engage in healthy habits.

- Promoting routine engagement

By restricting the score calculation to a once-daily activity, users are prompted to develop a routine around monitoring and improving their lifestyle scores. This daily interaction serves as a constant reminder of their health goals and the steps needed to achieve them. It creates a structured opportunity for reflection on daily activities, diet, physical exercise, and overall health management, fostering a proactive mindset towards diabetes management.

- Educational feedback

In conjunction with the scoring, users received tailored advice on areas where they scored poorly, along with actionable suggestions for improvement. This feedback ranged from increasing daily step counts to enhancing hydration levels. The provision of timely, contextual information played a crucial role in positively influencing users' behavior by making the path to improvement clear and attainable.

- Social sharing

Finally, we leveraged the power of social influence by enabling users to share their scores and achievements on social media platforms and *via* WhatsApp. This feature not only allowed users to celebrate their successes but also served to reinforce the positive behavior loop. Sharing accomplishments created a supportive community atmosphere, where positive reinforcement from peers further encouraged users to continue their healthful practices.

The incorporation of gamification elements into the Lifestyle Score Calculator has demonstrated significant potential in promoting healthy lifestyle changes. Through social proofing, loss and avoidance strategies, educational feedback, and social sharing capabilities, we have effectively engaged users in a manner that is both motivating and sustaining. These strategies have contributed to a notable improvement in lifestyle scores among individuals managing diabetes, underlining the importance of innovative, user-centered approaches in healthcare interventions.

Limitations and Future Research

While the study provides valuable insights, it is not without limitations. The study focused on short-term outcomes over six months, and the long-term impact of the Lifestyle Score Calculator remains to be seen. Future research should explore the sustainability of these lifestyle changes and their impact on long-term health outcomes. Additionally, the study was conducted within a specific population using the BeatO mobile application, and the results may not be generalizable to other settings or populations.

Conclusion

The findings highlight the effectiveness of the Lifestyle Score Calculator in promoting positive transitions across lifestyle categories, particularly among those with initially lower scores. The category-specific analysis provides granular insights, demonstrating notable improvements in specific lifestyle aspects, such as eating and drinking habits and blood glucose management. These results affirm the potential of personalized interventions based on lifestyle scores to facilitate sustained positive lifestyle changes among individuals managing diabetes. Further research and continuous monitoring will enhance our understanding of the long-term impact of these interventions and contribute to the refinement of personalized diabetes management strategies.

Conflicts of Interest

There is no conflict of interest to declare for this study.

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