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ACCEPTANCE, USABILITY, AND FUNCTIONAL IMPACT OF A SMART SENSING-BASED PHYSICAL ACTIVITY APPLICATION AND ITS RELATIONSHIP WITH QUALITY OF LIFE IN VISUALLY IMPAIRED ADULTS WITH TYPE 2 DIABETES

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Visual impairment, Type 2 Diabetes, physical activity, mobile health application, technology acceptance, usability, quality of life, cross-sectional study.

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Abstract

Background: *People with Type 2 Diabetes (T2D) and with impaired vision have challenges in incorporating physical activity in their daily lives for several reasons including the lack of accessible means to assess their physical activity, and inadequacies in the available diabetes-management applications. Real time physical activity feedback and reminders systems may be more acceptable to this population than existing systems.*

Objective: *The main objectives of this study were to assess the user acceptance of a real time physical activity feedback and reminders system (Lazarillo-Accessible GPS) based on the Unified Theory of Acceptance and Use of Technology (UTAUT) and to assess its usability. This study also aimed to determine the effects of using Lazarillo- Accessible GPS and its relation to the quality of life of visually impaired adults with T2D.*

Methods: *The design of this study was analytical cross-sectional. The participants were 90 adults, 24 to 66 years of age with Type 2 Diabetes and visual impairment. The participants completed an online, accessible, 5-part questionnaire to assess their opinions on the technology acceptance model, usability of Lazarillo-Accessible GPS, its effects on their everyday life and quality of life.*

Conclusion: *The participants' mean age was 48.2 (±9.7) years. The average acceptance level for the technology was positive (M = 4.22, SD = 0.49), with the element of 'ease of use' determining the level of acceptance. The participants found the technology was simple to use, and positive attitudes toward the technology increased the mean score for the System Usability Scale (SUS) to 71.28 (±14.05). The participants expected that the technology would improve their health, and positively impacted their lives (M = 4.03, SD = 0.46). The participants reported that use of the technology had a moderated effect on their Quality of Life (M = 3.39, SD = 0.58). The composite outcomes were positively related (rs = 0.32 to 0.62, p < 0.01). Acceptance and usability of the technology, and Quality of Life, were negatively related to age (p < 0.05, all cases).*

INTRODUCTION

The rate of increase in Type 2 Diabetes (T2D) cases is outpacing the capacity of the health care system to provide adequate care. Approximately 537 million adults are living with Diabetes, with the number expected to rise to 783 million by

the year 2045 (1). Physical activity can help in the management of blood glLowerCase case glucose level and assist in the prevention of cardiovascular disease. However, there are other challenges posed by an increasing public health concern, including visual impairment. There are approximately 295 million cases of moderate to severe visual impairment and 43 million cases of visual impairment including blindness. Visual impairment leads to an inactive and sedentary lifestyle which further complicates pre-existing conditions and increases the risk of other health threats (2).

These conditions frequently occur together. Chronic high blood sugar caused by diabetes can lead to blindness (3). This condition is known as diabetic retinopathy. Diabetic retinopathy is a leading cause of blindness, especially among adults under the age of 60, and is particularly prevalent among the populations of South Asia and other lower and middle income countries. This condition is on the rise in these regions(4). There are a host of barriers to physical activity for individuals with type 2 diabetes. For individuals with type 2 diabetes and diabetic retinopathy, the barriers to physical activity combine to create a greater barrier. This is particularly problematic because most fitness and health applications do not include features that are compatible with a screen-reader or other assistive technology. This means that, once again, individuals with type 2 diabetes and diabetic retinopathy cannot use these applications to improve their physical health and fitness (5). There is evidence to suggest that the use of applications that incorporate smart sensors to provide feedback on physical activity would benefit the general population to achieve improved physical activity and health (6). The acceptance and usability of such applications by individuals with type 2 diabetes and sight loss is unknown.

This research study explores a physical activity application that uses smart sensors and assesses its acceptance, usability, and influence on the quality of life of adults with type 2 diabetes mellitus (T2DM) who are blind or have impaired vision. There are knowledge gaps regarding the influence of technology, particularly mobile applications, to improve physical activity of people with visual impairment who are diagnosed with T2DM. There are several barriers that impede the achievement of physical activity for people with T2DM; some of these barriers include visual impairment and other limitations. Various mobile health (mHealth) interventions have been developed to facilitate diabetes self-management of people who are not visually impaired (7). Other mobile health interventions have been developed to facilitate the self-management of people with visual impairment; however, these interventions focus on different health conditions other than diabetes (8). Therefore, the present study explored the influence of a mobile application designed to improve physical activity on the quality of life of people with visual impairment and diabetes (9).

Significance of the Study

In this study, we combine efforts toward two major public health challenges. The first challenges include the vision-threatening consequences of uncontrolled chronic blood sugar (sugar) levels. Diabetic Retinopathy is one of the major reasons for working-age adults' blindness, especially in South Asia and other developing countries (10). The second challenge includes physical inactivity, which leads to adverse health conditions. Currently, available health and fitness applications do not support persons with visual impairments. Consequently, the applications are of no use to persons with visual impairments who also suffer from physical inactivity.

Even though, research has focused on the development of "smart" and sensing technology to encourage and support physical activity for various user groups, the research has neglected users with type-2 diabetes mellitus and vision impairment. The research has primarily supported and encouraged physical activity among the general user groups. Consequently, evidence-based recommendations and support are lacking for health care professionals and allied service personnel for the visually impaired group. The research presented here will evaluate a technology-based physical activity support and promote system among 90 adult users with type-2 diabetes mellitus and vision impairment. Acceptance and usage of the system will be analyzed. Depending on users' age, education,

and experience with information technology, other parameters will be evaluated.

LITERATURE REVIEW

It is believed that more than 536 million adults between the ages of 20 and 79 have diabetes, the vast majority of which is Type 2. This number is expected to increase to about 643 million adults by 2030 and 783 million adults by 2045 (11). There are many consequences of diabetes including damage to the body's organs and tissues due to loss of function of the body's blood vessels. This includes damage to the eyes. As noted above, diabetes is a chronic condition and there are several self-management strategies including regular exercise. It has been recommended that people with Type 2 diabetes participate in at least 150 minutes of moderate to vigorous exercise each week including exercising with resistance (12). It has been reported that there are barriers including, medical conditions, and motivation that prevent people from participating in recommended exercise. Some studies have reported that mobile technology and applications can help reduce HbA1c, which is a key component of blood that can help determine how well people with diabetes are managing their condition (13). It has also been reported that mobile applications to assist with diabetes management are inadequate to assist persons who are visually impaired or completely blind.

Visual impairment is a growing global health challenge. In 2020, approximately 43.3 million people had blindness, and 295 million people had moderate to severe visual impaction (14). World Health Organization (WHO) data demonstrate that people with visual impairment have an increased risk of falls and social isolation (15). Unaddressed visual impairment may accelerate cognitive decline and increasing sedentary behavior. Data from the UK Biobank showed that people with glaucoma, age-related macular degeneration and diabetic retinopathy are less physically active (16). Therefore, vision loss may contribute to reduced physical activity and increase sedentary behavior. Fears of falling and other safety concerns have been reported as barriers for the visual impaired in using assistive technology to improve their health and fitness (17).

Diabetic retinopathy (DR), a complication of diabetes, is a leading cause of blindness and visual impairment (18). According to the World Health Organization (WHO), over 18 million people live with the consequences of diabetes-related retinopathy. The Global Burden of Disease Study shows the prevalence of vision loss from diabetes in the working age population (between 25 to 65 years of age) has steadily increased since 1990 (19). Between 2021 and 1990, the prevalence of working age adults with diabetes-related vision loss nearly tripled. From 2021 to 2015, diagnostic equipment used to assess physical activity level in the general population and people with visual impairment was found to be inadequate (20). The design of assistive technology to address physical activity limitations due to visual impairment does not adequately consider the barriers associated with self-management of diabetes. This technology also does not address the requirements of people with visual impairment and diabetes to access the internet. Web Content Accessibility Guidelines (WCAG 2.0 or 2.1) defines standards and requirements of accessible technology (21). Web accessibility can also be addressed by design and development of technology to interact with Internet of things devices.

These studies show there is a growing need and interest for accessible mHealth designs, and that there is little to no research focusing on accessible mHealth designs for physical activity and fitness relating to chronic metabolic conditions. Real time physical activity sensing and feedback technology has the potential to address some of the challenges associated with the use of digital activity and fitness-related interventions by people with chronic metabolic conditions (22). Sensor and feedback technology can also be embedded within mHealth applications. Feedback technology has the potential to strengthen and amplify existing activity and fitness-related interventions. Most research supporting the use of sensor technology to improve activity-related interventions for older people is relatively new and developing (23).

The outcome measures in the study are founded upon three theoretical and psychometric frameworks. The first of these is the Unified

Theory of Acceptance and Use of Technology (UTAUT) (24). This theory was developed to understand and model the adoption and use of various types of technology in the workplace. This theory incorporates various factors, including performance expectancy, effort expectancy, social influence and facilitating conditions. It explains approximately 70% of the variation in the intention to use a given technology. A more recent version of the UTAUT model incorporates hedonic intent, price value and usage habit (25). This model also integrates trust and personal innovativeness. The System Usability Scale (SUS) is another theory incorporated in this study. It is used to assess the usability of a technology (26). The final of the theories incorporated in this study is the WHOQOL instrument. This theory incorporates both the assessment of quality of life and the factors that impact quality of life. A key feature of this theory is the inclusion of the health status and health related concerns of an individual (27).

Objectives

The main goal of this study was to assess the UTAUT-based user acceptance and the perceived usability of a smart sensing-based physical activity application using the System Usability Scale, and to analyze the effect of the application on physical activity and the user's sense of independence and quality of life. This study also assessed the effects of the application on overall physical activity and quality of life.

Hypotheses

H1 (Alternative): In adults with T2D and visual impairment, the Smart Sensing Application has a positive effect on functional outcomes and quality of life, and is acceptable and easy to use.

H0 (Null): The acceptance and usability of the Smart Sensing Application have no effect on the functional outcomes and quality of life of adults with T2D and visual impairment.

Operational Definitions

Technology Acceptance: Includes user's readiness and willingness to use a particular technology and comprises Performance Expectancy, Effort Expectancy, and Behavioral Intention (28).

Usability: Refers to the degree to which a given person/user is able to use a system/software to achieve a given task in an effective and efficient manner and with a high level of satisfaction (29).

Functional Impact: Refers to the effect of a technology/intervention on the participant's physical activity, confidence in performing the activity, sense of independence while performing the activity, and overall safety (30).

Quality of Life: Involves the physical, psychological, social, and environmental wellbeing of an individual (31).

Visual Impairment: Refers to the deferent levels of vision loss (partial, complete) and blindness (32).

Smart Sensing Technology: Refers to the use of mobile device technologies (accelerometers, gyroscopes, etc.) to sense and evaluate individual's physical activity (33).

Literature Gap

Research on Type 2 Diabetes (T2D), on participatory methods for self-management, on the relationship between physical activity and visual impairment (in the context of diabetic retinopathy), and on the design of mHealth apps, has been conducted in separate fields. The combination of all the aforementioned factors has not been investigated within the field of research. The present study aims to fill this research void.

3. METHODOLOGY

This chapter describes how the acceptance, usability, functional impact and quality of life (QOL) of smart sensing-based physical activity applications for visually impaired adults with Type 2 Diabetes have been measured. It also identifies relationships that exist among these constructs.

3.1 Research Design

The study used an analytical, cross-sectional design. Quantitative and qualitative data were

collected using a single, self-reported questionnaire. No controls or interventions were implemented. The design enabled description of the relationships between the four outcome measures (acceptance, usability, effect on functional status, and quality of life) and the demographic information (age, gender, and education) of the study participants.

3.2 Population and Sampling

The research subjects were visually-impaired adults with Type 2 Diabetes who had used the smart sensing-based physical activity application. The researcher utilized non-probability, purposive, convenience sampling (34). The researcher's goal of 90 participants exceeded the minimum suggested sample size of 24-30 participants for reliability testing at 80% power and alpha (α) of 0.05 (35).

Inclusion criteria: The study evaluated participants aged 42 to 65 (36).
Participants reported any degree of impairment from retinopathy including limited or no light perception (37).
A diagnosis of Type 2 Diabetes was made prior to the study (38).
The capacity to understand the study and provide informed consent was required. This understanding could be aided by a supportive person (39).

Exclusion criteria
The study excluded participants who did not provide informed consent, regardless of the presence of alternative consent methods (39).
Participants with previous experience with the study app were excluded (40).
Participants with Type 1 Diabetes were excluded.
Participants with cognitive or communicative impairments that prevented them from completing a self-report survey with or without assistance, were excluded (41).

3.3 The Study Application: Lazarillo – Accessible GPS

Lazarillo is a free, fully accessible GPS navigation app for people with visual impairments. It is available on the App Store and Google Play. Using GPS and the speaker, the app provides audible directions and information about surrounding environments (42). The app was chosen to be evaluated in the study because it demonstrates the potential to adjust and adapt to a user's movement outside of the app. This study analyzes Lazarillo to understand the type and degree of movement sense and response capability of the app.

3.4 Research Instrument

Data were collected using a five-section, accessible-format questionnaire (screen-reader/voice-over compatible), rated on a 5-point Likert scale, summarised in Table 1.

Table 1. Structure of the Data Collection Instrument

Section	Domain	Items	Source
A	Demographic and background	11	Researcher-developed
B	Technology acceptance	8	Adapted from UTAUT (43)
C	Perceived usability	10	System Usability Scale (44)
D	Functional impact	6	Researcher-developed, aligned with T2D physical activity guidelines (45)
E	Quality of life	7	Adapted from WHOQOL-BREF (46)

3.5 Data Collection Procedure

Participants were called and the survey explained. Participants were able to read the survey using software or had a research assistant read the survey and answer the questions for them. Surveys were checked to make sure all the questions had been answered before they were reviewed.

3.6 Data Analysis

Data analysis was done using SPSS and comparable modules in Python (SciPy, Pingouin). Descriptive statistics (counts, percentages, means, and standard deviations) were computed for the variables. The Shapiro-Wilk test was done to assess the normality of the four composite outcome variables. The rank-order correlation of age was computed using the Spearman correlation. The Mann-Whitney U test was done to compare outcomes based on gender and to compare outcomes of physical activity app users and non-users. The Kruskal-Wallis H test was done to compare outcomes based on the level of education.

3.7 Ethical Considerations

Ethical approval was obtained prior to participant engagement. Informed consent was obtained in accessible format, with audio or read-aloud options provided. Responses were anonymized, and access was restricted to the research team; no participant-identifying information is reported.

4. RESULTS

Of 90 completed questionnaires, all 90 (100%) had complete responses on the Likert-scale items in Sections B (Acceptance), C (Usability), D (Functional Impact), and E (Quality of Life). Fourteen participants (15.6%) did not complete Section A (demographic items), leaving n = 76 for the demographic and subgroup analyses reported below; age was available for all N = 90 participants (M = 48.2, SD = 9.7, range 24–66 years).

Distributional properties of the four composite outcome variables were examined using the Shapiro-Wilk test. Acceptance (W = 0.964, p = .013) and SUS Usability (W = 0.972, p = .048) departed from normality, whereas Functional Impact (W = 0.979, p = .159), Quality of Life (W = 0.981, p = .229), and Age (W = 0.977, p = .105) conformed reasonably well to a normal distribution. Non-parametric methods (Spearman correlation, Mann-Whitney U, Kruskal-Wallis H) were therefore used throughout for inferential comparisons.

4.1 Sample Characteristics

Table 2. Demographic Characteristics of Participants (n = 76)

Variable	Category	N	%
Gender	Male	37	48.7
	Female	37	48.7
	Prefer not to say	2	2.6
Marital status	Married	54	71.1
	Single	12	15.8
	Other	10	13.2
Educational level	Graduate	27	35.5
	Postgraduate	23	30.3
	Secondary	11	14.5
	Intermediate	8	10.5
	Primary	7	9.2
Occupation	Employed	35	46.1
	Unemployed	30	39.5
	Retired	7	9.2
	Student	4	5.3

Variable	Category	N	%
Duration of T2D	6–10 years	25	32.9
	1–5 years	21	27.6
	>10 years	19	25.0
	<1 year	11	14.5
Type of visual impairment	Low vision	48	63.2
	Blindness	28	36.8
Prior physical activity app use	No	48	63.2
	Yes	28	36.8

Note. Fourteen of the 90 participants (15.6%) did not complete Section A demographic items and are excluded from this table; age (M = 48.2, SD = 9.7, range 24–66) was available for all N = 90 participants.

4.2 Reliability of the Questionnaire Sections

Internal consistency of each multi-item section was assessed using Cronbach's alpha (α ≥ .70 acceptable, ≥ .80 good, ≥ .90 excellent). All four sections demonstrated acceptable-to-good internal consistency, supporting their use as composite outcome variables (Table 3).

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Table 3. Cronbach's Alpha Reliability Coefficients by Section

Section	Items	Cronbach's α	95% CI	Interpretation
Technology Acceptance (UTAUT)	8	0.795	0.72–0.85	Acceptable
Usability (SUS, reverse-coded)	10	0.804	0.74–0.86	Good
Functional Impact	6	0.722	0.62–0.80	Acceptable
Quality of Life (WHOQOL-based)	7	0.757	0.67–0.83	Acceptable

4.3 Composite Outcome Scores

Table 4 summarises the four composite outcomes. Overall technology acceptance was rated favourably (M = 4.22, SD = 0.49, on a 1–5 scale); the highest-rated item was perceived usefulness for health management (M = 4.47, SD = 0.54), and the lowest-rated was ease of learning (M = 3.66, SD = 0.88). The composite SUS usability score was 71.28 (SD = 14.05, range 32.5–100), above the published digital-health benchmark of 68. Functional impact was rated positively (M = 4.03, SD = 0.46); the highest-rated item was the application's encouragement of daily physical activity (M = 4.29, SD = 0.74), and the lowest-rated was perceived safety during activity (M = 3.70, SD = 0.87). Quality of life was more moderate overall (M = 3.39, SD = 0.58); the highest-rated item concerned feeling safe and comfortable in one's environment (M = 3.99, SD = 0.55), and the lowest concerned the impact of health condition on enjoyment of life (M = 2.42, SD = 0.87).

Table 4. Composite and Selected Item-Level Descriptive Statistics

Outcome	Composite M (SD)	Highest-rated item (M)	Lowest-rated item (M)
Technology Acceptance	4.22 (0.49)	Useful for managing health (4.47)	Easy to learn (3.66)
SUS Usability (0–100)	71.28 (14.05)	—	—

Outcome	Composite M (SD)	Highest-rated item (M)	Lowest-rated item (M)
Functional Impact	4.03 (0.46)	Encourages daily activity (4.29)	Feel safer during activity (3.70)
Quality of Life	3.39 (0.58)	Feel safe/comfortable in environment (3.99)	Health condition limits enjoyment of life (2.42)

4.4 Construct Relationships

Spearman's rank-order correlations among the four composite outcomes and participant age are shown in Table 5 and Figure 1. All four outcome variables were positively and significantly intercorrelated (rs = 0.32–0.62, p < .01), with the strongest association between Acceptance and SUS Usability (rs = 0.62). Age was negatively correlated with Acceptance (rs = -0.35, p < .001), SUS Usability (rs = -0.46, p < .001), and Quality of Life (rs = -0.25, p = .016), but was not significantly related to Functional Impact (rs = -0.05, p = .623).

Table 5. Spearman Correlation Matrix Among Study Variables (N = 90)

	Age	Acceptance	SUS Usability	Functional Impact	Quality of Life
Age	1.00	-0.35**	-0.46**	-0.05	-0.25*
Acceptance	-0.35**	1.00	0.62**	0.32**	0.40**
SUS Usability	-0.46**	0.62**	1.00	0.34**	0.49**
Functional Impact	-0.05	0.32**	0.34**	1.00	0.35**
Quality of Life	-0.25*	0.40**	0.49**	0.35**	1.00

** p < .05, ** p < .01 (two-tailed).*

Figure 1. Spearman Correlation Matrix Among Study Variables (N = 90)

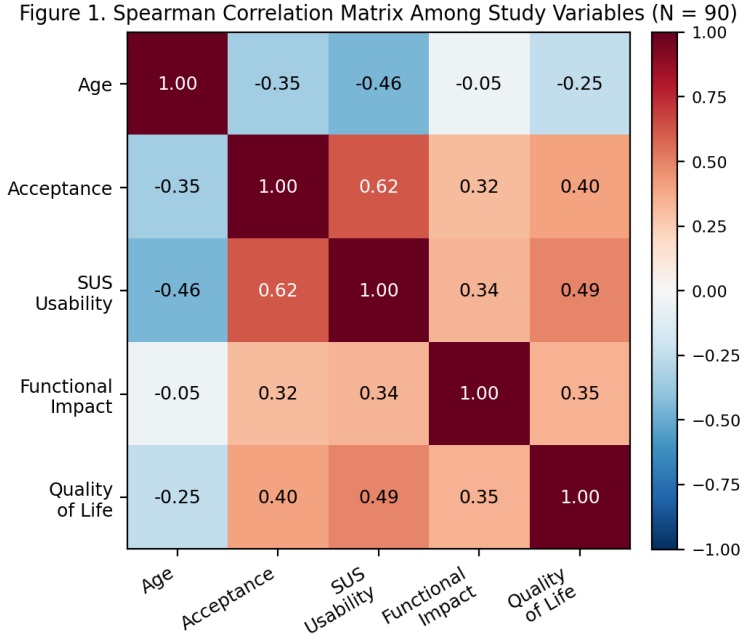


Figure 1. Spearman correlation matrix among age, technology acceptance, SUS usability, functional impact, and quality of life (N = 90).

4.5 Subgroup Comparisons

Mann-Whitney U tests compared composite outcome scores by prior physical-activity-app experience and by gender (Table 6); Kruskal-Wallis H tests compared scores across five educational-level groups (Table 7). All group comparisons used the 76 participants with complete demographic information.

Table 6. Mann-Whitney U Test Results for Selected Subgroup Comparisons

Outcome	Comparison	Medians	U	p	Result
Acceptance	Prior app use: yes (n=28) vs no (n=48)	4.42 vs 4.28	885.5	.022	Significant
SUS Usability	Prior app use: yes vs no	74.5 vs 72.4	859.5	.044	Significant
Functional Impact	Prior app use: yes vs no	4.16 vs 3.93	774.5	.272	Not significant
Quality of Life	Prior app use: yes vs no	3.67 vs 3.31	1022.0	<.001	Significant
Acceptance	Gender: male (n=37) vs female (n=37)	4.44 vs 4.20	909.5	.015	Significant
SUS Usability	Gender: male vs female	73.0 vs 72.4	738.5	.563	Not significant

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Table 7. Kruskal-Wallis H Test Results by Educational Level (n = 76)

Outcome	H	df	P	Result
Acceptance	4.56	4	.336	Not significant
SUS Usability	8.91	4	.063	Not significant
Functional Impact	4.14	4	.388	Not significant
Quality of Life	10.65	4	.031	Significant

With educational subgroups of n = 27 (Graduate), 23 (Postgraduate), 11 (Secondary), 8 (Intermediate), and 7 (Primary), Quality of Life differed significantly across education levels ($H = 10.65$, $p = .031$); Acceptance, SUS Usability, and Functional Impact did not reach significance at $\alpha = .05$.

DISCUSSION

The UTAUT framework identifies the main acceptance driver as performance expectancy. In this case, participants evaluated the utility of the application to assist in their health management (M = 4.47). Conversely, perceived ease of learning was evaluated to be (M = 3.66). This implies that the application may assist in health management but may require an effort and time investment to learn the application. This evaluation is consistent with prior evaluations of similar applications and the reliance of the visually impaired to engage in other means apart from the application to assist in learning. According to the UTAUT2 framework, users of similar applications in the past, evaluated the application positively (acceptance) in line with their experience and willingness to adopt technology.

The mean SUS score, (M = 71.28, SD = 14.05) places it in the "good" category. The score is above the published benchmark of 68 for digital health and medical applications. The higher score may be attributed to the SUS employing a comparative analysis to other applications rather than absolute measurements. While the overall evaluation of the application was positive (mean = 4.07, range = 1.49), some users reported negatively (mean = 1.88, range = 1.88) to the application during the test. Recent studies suggest that the SUS assesses two different constructs (learner in a task and usability). Items

relating to the interaction design of the application (learner in a task) were rated positively, while items relating to support and learning (usability) were negatively rated.

The application's main functional benefits were seen in promoting daily physical activity (M = 4.29) and beneficial changes in participants' health and wellness (M = 4.23). This is in line with studies that report the use of sensor-based feedback and goal-directed activity systems by various populations to enhance and increase their physical activity (4). The application was also aligned with clinical guidelines to integrate technology to assist people with Type 2 Diabetes to increase physical activity (45). The application score ratings indicated that participants felt safe while using the application to facilitate their physical activity (M = 3.70). Overall, the application succeeded in motivating and helping participants with Type 2 Diabetes to engage in physical activity. However, the application's biggest opportunity for improvement is addressing participants' concerns about their safety while engaging in physical activity.

Average quality of life was rated lower (M = 3.39) than the other considerations assessed. Users rated lowest the impact of the condition on the ability to perform everyday activities (M = 2.88) and the ability of the user to enjoy life (M = 2.42). This may be attributed to the finding that the wellbeing of persons with visual impairment may be impacted in several different ways (2). This is also aligned with the WHOQOL research that identified that the effects of Type 2 Diabetes on quality of life is complex and that self-management of the condition does not alleviate the effects (31). Quality of life was related to all the constructs assessed, with the highest relationship was with usability (rs = 0.49). This means that the study participants who found the application to be more usable, also reported more positive quality of life. These findings indicate that for participants who use the application to improve their quality of life, the application may only be one element to the numerous other ways in which quality of life may be negatively impacted due to the condition and comoritation (47).

High and consistent correlations were seen between acceptance, usability, functional impact, and quality of life (rs = 0.32 - 0.62). This supports the presence of a logical chain between acceptance and usability, and functional and quality of life impacts. The highest of these correlations (rs = 0.62) was found between acceptance and SUS. Thus, in this case, acceptance and usability were assumed to be closely related. The finding that older participants scored lower on acceptance, usability, and quality of life (but not functional impact), supports the notion that in the context of mHealth, users who are blind and visually impaired, like other older adult users, may experience technology-related barriers and digital literacy challenges, and should not be considered as a single user group. It was also found that participants who, in the past, used another app similar to the study app, evaluated it higher than first time users, in all three domains (acceptance, usability, and quality of life). Thus, it may be the case that first time users of the app need more support to help them use it, and evaluate it more favorably, like it's use was intended. Lastly, the difference in quality of life between the different educational attainment groups may also reflect differences in digital literacy. However, the smaller size of these groups limits the conclusions that may be drawn.

CONCLUSION

This study analyzed a physical activity app using the UTAUT and SUS frameworks, and assessed its impact on quality of life. The study recruited 90 visually impaired participants with Type 2 Diabetes. The results showed the app positively impacted quality of life, and encouraged participants to be active throughout the day. The app was easy to use, and helped participants manage their health. The app positively impacted participants' health, and encouraged participants to be physically active. The app positively impacted safety and quality of life, however, the results showed that participants still had a moderate to large burden on their quality of life. The positive impact of the app on health and safety promoted participation among the target population. Prior experience with technology and gender were not significant in the results.

Table 8. Study Conclusions Mapped to Research Objectives

Objective	Key finding
Technology acceptance (UTAUT)	Favourable overall (M = 4.22/5, α = 0.795), driven by perceived usefulness for health management.
Perceived usability (SUS)	Good (M = 71.28/100), above the digital-health benchmark of 68, with wide variability across participants.
Functional impact	Clear perceived benefit for activity engagement and independence (M = 4.03/5, α = 0.722).
Quality-of-life outcomes	More moderate (M = 3.39/5), particularly on energy and life-enjoyment items.
Construct relationships	All four constructs significantly, positively intercorrelated (rs = 0.32–0.62, p < .01).
Demographic differences	Age negatively associated with acceptance, usability, and quality of life; prior app experience associated with better outcomes; gender differences largely non-significant.

Recommendations

- Because learnability items received low acceptance and usability scores, Features such as a tutorial or similar step-by-step initiative, are potentially acceptable and usable.
- Safe physical activities should be promoted to the extent possible. Providing users with feedback about obstacles and/or dangers in their vicinity may help users avoid unsafe situations and may reduce the barriers to physical activities.
- The extent of the first-time user experience should be individualized based on the user's familiarity with physical activity apps.
- Since improving the health-related quality of life of the study participants remains sub-optimal, the app may be recommended as one component of a larger self-management strategy.
- Older and less tech-savvy users should be offered extra assistance when recommended apps are provided to the user.
- Given the preliminary nature of the present study, the authors recommend that larger studies be conducted to test the hypotheses presented in the study.
- Objective measurements of health and wellness (i.e. activity monitoring devices, lab tests) should be used to assess the impact of the intervention, when possible.
- Future studies may revisit assessment of the sub-scales of the SUS.

Limitations

The use of purposive convenience sampling reduces the study's generalizability. However, the sample size (N = 90) allowed detection of the effects reported here and was found to be reliable. The limitation of sample size reduced the power to detect differences for some comparisons; further, a high number of sub-groups (e.g. age, gender, ethnicity, and education) were under-represented in the study sample. The completion of Section A by 76 participants enabled a variety of analyses. The cross-sectional nature of the study allowed understanding of study participants' perceptions. Longitudinal and causal studies would be necessary to assess the impact of the application on study participants' physical activity and quality of life. Given the nature of the study and the platform under investigation, a single researcher was the primary judge of usability and learnability of the application.

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