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Knowledge on self-management of diabetic patients among their relatives in a selected diabetes center in Dhaka Bangladesh

[1] Lovly Akther, [2] Sarder Mahmud Hossain, [3] Bilkis Banu and [4] Nasrin Akter

[1] RN, BSN, MPH (NUB), Senior Staff Nurse, National Institute of Neurosciences and Hospital in Dhaka, Bangladesh

[2] MBBS, MPH (HM), Ph.D. Professor and Head, Department of Public Health, Northern University, Dhaka, Bangladesh

[3] MSc, MPH, PhD Scholar, Associate Professor, Department of Public Health, Northern University, Dhaka, Bangladesh

[4] BDS, MPH, Lecturer, Department of Public Health, Northern University, Dhaka, Bangladesh

Corresponding Author: Lovly Akther

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Abstract

Mobile technology represents an innovative approach to communicating with patients about diabetes education. However, no studies have investigated the effectiveness of mobile Short Message Service (SMS) in enhancing knowledge and beliefs about diabetes among the family members of patients. Therefore, the present study was conducted to assess the effectiveness of SMS in strengthening diabetes-related beliefs among relatives. This cross-sectional study involved 325 participants, with 188 in the SMS Group and 137 in the Non-SMS Group, all attending the outpatient department of a selected tertiary care diabetes center. Participants were selected purposefully. During the baseline visit, each participant's knowledge regarding diabetes was assessed using a pre-designed questionnaire. Following this, both groups received an educational session delivered on a one-to-one basis by a trained diabetes educator. An educational intervention focusing on a healthy lifestyle was delivered through SMS to the Non-SMS Group. The SMS Group received two messages per day for two months. At the end of the study, both groups completed the same questionnaire for data collection. Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 17.0. The mean age of participants' relatives was 34.58 ± 11.91 years in the SMS group and 31.02 ± 11.51 years in the Non-SMS group, respectively. No significant differences in belief levels between the two groups were noted at baseline. However, following the SMS intervention, the SMS group showed a significantly higher level of knowledge ($p \leq 0.0001$), while the Non-SMS group exhibited only a slight increase in knowledge ($p \leq 0.0001$). These results suggest that mobile phone messaging is an innovative and effective tool for improving beliefs and reducing misconceptions about diabetes mellitus among relatives. Further large-scale studies are needed to validate these findings.

Keywords: Self-Management, knowledge, Diabetic Patients, Relatives

Introduction

Diabetes mellitus (DM) is a significant global health issue, leading to considerable clinical, social, and economic impacts. It is a common and expensive chronic metabolic disease associated with substantial premature mortality and morbidity, necessitating medical diagnosis, treatment, and lifestyle modifications. The burden of diabetes is rising, particularly in developing countries, due to the rapid transition from traditional lifestyles to Westernized and urbanized cultures. The International Diabetes Federation (IDF) reports that the prevalence of diabetes has reached epidemic proportions worldwide. In 2014, approximately 387 million people were living with diabetes, and by 2035, this number is projected to exceed 205 million [1].

The burden of diabetes and diabetes-related mortality is increasing in Southeast Asia (SEA). Nearly one-fifth of all adults with diabetes worldwide reside in this region. The prevalence of diabetes in SEA was 8.3% in 2014 and is projected to rise to 10.1% among people aged 20-79 by 2035. In 2013, there were approximately 72.1 million individuals with diabetes in SEA, and this number is expected to climb to 123 million by 2035. Additionally, the prevalence of impaired glucose tolerance (IGT) was 2.7% in 2013, with expectations of an increase to 3.2% by 2035 for the same age group. SEA has the second-highest number of diabetes-related deaths among the seven regions identified by the International Diabetes Federation (IDF), with over 1.1 million deaths reported in 2014 for individuals aged 20-79. Despite the significant number of people living with diabetes in the region, healthcare spending on diabetes in SEA was estimated at only USD 6.0 billion in 2014, which accounts for less than 1% of the global total [1].

Bangladesh is a developing country located in Southeast Asia, where the population is rapidly increasing, and the healthcare system is struggling.2 The population of Bangladesh is approximately 16 million, but 40% of the people lack access to even basic health services.3-4 In 2014, the prevalence of diabetes in the country was 6.8%, and it is

projected that by 2035, Bangladesh will be among the top ten countries with the highest numbers of diabetes cases [1].
Numerous studies have shown that better glycemic control reduces the rate and frequency of diabetes-related complications. Evidence suggests that patients who are more knowledgeable about diabetes self-care are more likely to achieve improved glycemic control [5]. Effective management requires patients to understand the nature of the disease, its treatment options, risk factors, and potential complications [6]. Patient education plays a vital role in enhancing their understanding and ability regarding both their condition and its management. This, in turn, leads to an improved quality of life, better adherence to treatment, and a decrease in complications [7]. A study conducted at the University of Venda indicated that the outcomes of diabetes depend largely on the patient's self-management. Consequently, healthcare professionals bear the primary responsibility of equipping patients with the knowledge, skills, and attitudes necessary for effective self-management.8 However, non-adherence rates for therapies related to chronic illnesses and lifestyle modifications are alarmingly high, ranging from 36% to 93%, with an average of about 50% in developed countries [9]. Moreover, a recent study conducted among newly diagnosed type 2 diabetes patients in Bangladesh found that 90% of them had average to poor basic knowledge about their condition [10].
Managing diabetes involves several key components, including dietary adjustments, physical activity, self-monitoring of blood glucose, diabetes medications, behavioral strategies for promoting lifestyle changes, and education on how to integrate these components and healthy habits into daily life [11]. Education is most effective when we understand the characteristics of patients, including their knowledge, attitudes, and practices regarding diabetes [12]. Factors such as age, sex, education level, socioeconomic status, family history of diabetes, media exposure, and the ability to follow doctors' advice all influence the knowledge that diabetic patients and their relatives have about the condition. In a developing country like Bangladesh, where the adult literacy rate is only 54.9%, there is a heightened risk of inadequate guidance about diabetes due to a lack of understanding among patients.13 These challenges can be addressed if patients receive proper training. Effective self-management requires individuals to be aware of the disease's nature, potential complications, risk factors, and treatment options.14-15 Access to information can empower individuals to assess their risk of diabetes, motivate them to seek appropriate treatment and care, and encourage them to take an active role in managing their health throughout their lives [16].
Patient education is a crucial aspect of diabetes care, yet there is still some uncertainty about the effectiveness of various educational intervention methods. Traditional health education (THE), typically delivered by health assistants, is a common approach to enhance diabetes management and reduce the risk of complications. The consists of a series of educational interventions designed to provide individuals with health information and encourage them to adopt attitudes and behaviors that promote their well-being.
Knowledge plays a vital role in any future disease development and its early prevention and detection [17]. A positive knowledge and belief are important for diabetic patients. These are interrelated and independent on each other. If output of one of these is better than it will affect the other positively. Knowledge and beliefs regarding diabetes greatly vary depending on socio-economic conditions, cultural beliefs and habits. As a result of this, diabetic education and counseling for the patient and family members are becoming important goals of diabetic patient care today.
In recent years, mobile phone interventions have emerged as a rapidly evolving practice aimed at improving the delivery of health services across many countries worldwide. These interventions have shown a significant impact, particularly in developing countries. The acceptance and utilization of mobile technology have grown rapidly; it is not only used for social communication but also plays an important role in industries such as finance, education, and marketing.18-20 Mobile health, or M-Health, refers to the use of mobile phone technology in medical practice and public health support through mobile devices. This includes text messaging, videos, voice calls, and Internet access [19-21].
M-Health can serve as a low-cost solution to provide health education and enhance treatment adherence for individuals with chronic diseases like diabetes. Short Message Service (SMS) is an effective method for delivering educational guidance and motivation for lifestyle modifications in primary prevention. It also helps improve patient compliance. SMS can be particularly beneficial for providing diabetes health education, sending clinic and appointment reminders, medication reminders, and raising awareness about the disease. This approach has proven effective in urban areas and among a young, educated population [22].
In 1995, people sent SMS messages approximately once every two and a half months.23 Bangladesh emerged as one of the leading countries in terms of SMS usage, with users generating a significant volume of messages. By 2010, more than 175 billion messages were sent in Bangladesh alone.24 It is estimated that individual users sent an average of 7 text messages daily, which amounted to about 200 messages per month until 2012 [25].
In many high-income countries, the number of mobile phone subscriptions exceeds the total population. In contrast, low-income countries have an average of 89 mobile phone subscriptions for every 100 inhabitants. Since mobile phone ownership is widespread and automated messaging software is accessible, interventions delivered through mobile phones that promote behavioral change can reach a large audience at a low cost [26].

Justification of the study

Non-communicable diseases, such as diabetes, can last a lifetime. However, patients can lead normal lives as long as the condition is well-managed. The complications associated with diabetes can lead to reduced life expectancy and significant healthcare costs [27]. Research has shown that continuous diabetes education can change patients' knowledge, attitudes, and practices. This improvement can lead to increased life expectancy and help prevent complications.
Lifestyle changes can prevent diabetes, and increased awareness can improve the life expectancy of patients who adhere to their medication plans. Traditionally, diabetes

education has been provided through individual and group sessions, often utilizing printed materials, demonstrations, and occasional audiovisual support. Recently, the rise of modern communication technologies, like mobile phones and the internet, has transformed educational strategies by enabling community-wide outreach. The use of information and communication technology (ICT) in diabetes education is gaining momentum in developed countries and is gradually beginning in developing nations. However, there is limited research on the impact of SMS (text messaging) on knowledge and beliefs about diabetes. Various studies have demonstrated that mobile messaging significantly enhances patients' adherence to their treatment plans [9], adherence to oral medications [28], disease prevention, and lifestyle modifications [29]. Additionally, it has been shown that support from family and relatives plays a crucial role in treatment adherence and lifestyle changes.8 Despite the high and increasing prevalence of diabetes and evidence that improved awareness leads to healthier outcomes, Bangladesh is experiencing a lack of well-planned education and knowledge-based programs for diabetic patients and those at high risk of the disease [30].

There is very limited literature on the knowledge, beliefs, and practices of people with diabetes in Bangladesh. A study that explored the knowledge of diabetic patients in Karachi found significant gaps within the study population. 31 Another study indicated that the knowledge, beliefs, and practices of diabetic patients were less than satisfactory.30 Bangladesh has one of the highest mobile phone densities in Asia. As of November 2014, there were 137 million mobile phone subscribers in Bangladesh, which is double the number from 2006 and 2007.32 given this widespread access, mobile phone-based SMS could potentially serve as an effective tool for educating patients and their families in Bangladesh. However, this potential should not be taken for granted; it is essential to investigate the extent and various dimensions of awareness among specific population groups and subgroups. In this context, the present study was conducted to assess the effectiveness of mobile SMS in improving beliefs about diabetes among relatives of patients.

Objectives

General Objective

To assess the knowledge of self-management regarding diabetes among relatives of diabetic patients in Dhaka City, Bangladesh.

Specific Objectives

1. To determine baseline and end-line beliefs about diabetes among relatives;
2. To assess the effectiveness of Mobile SMS in improving belief on diabetes among relatives;
3. To explore factors that may influence the effectiveness of mobile SMS in improving knowledge and beliefs among relatives;

Literature Review

A Brief History of Diabetes

Diabetes is one of the oldest chronic diseases and has been documented for thousands of years. The earliest known description of its symptoms can be found in the Ebers Papyrus, which dates back to around 1550 BCE.33 World Diabetes Day (WDD) is observed annually on November 14, a date established by the International Diabetes Federation (IDF) and the World Health Organization (WHO). This day aims to raise global awareness about diabetes, its increasing prevalence worldwide, and methods to prevent the disease in many cases. November 14 also marks the birthday of Frederick Banting, who, along with Charles Best, was instrumental in the discovery of insulin in 1922 [34].

About Diabetes

Diabetes is a chronic but manageable disease that occurs due to the lack of insulin in the body or when the body cannot use insulin efficiently.35 Due to the lack of insulin, glucose is not absorbed properly, and glucose remains circulating in the blood which causes destructive body tissues after a while. This damage can lead to disabling and life-threatening health complications [1].

Classification of DM

Mainly, there are three types of diabetes; pre-diabetes is a period before diabetes. Impaired Glucose Tolerance (IGT) is a pre-diabetic condition of hyperglycemia where blood sugar level rises to a higher level than the standard range, but is still not high enough to be considered diabetes. Pre-diabetic patients may develop Type-2 diabetes. It is a risk factor for mortality. 36 Most common forms of diabetes are there [1]:

- Type-1 diabetes
- Type-2 diabetes
- Gestational diabetes

Type-1 Diabetes Mellitus (T1DM)

Type-1 Diabetes Mellitus (T1DM) is the most common form of diabetes, often referred to as juvenile diabetes or insulin-dependent diabetes. It is a chronic condition in which the pancreas produces little to no insulin [37]. this occurs due to the progressive destruction of pancreatic beta cells, which are responsible for insulin production. Genetic factors and exposure to certain viruses may contribute to the development of type-1 diabetes [38]. Typically, type-1 diabetes develops suddenly and can lead to a variety of symptoms, including dry skin and mouth, increased thirst, frequent urination, extreme hunger, unintentional weight loss, mood changes, blurred vision, lack of energy, slow-healing wounds, and recurrent infections [1].

Type-2 Diabetes mellitus (T2DM)

Type-2 Diabetes Mellitus (T2DM) is one of the most common types of diabetes. While it typically occurs in adults, it can develop at any age. This condition is characterized by insulin resistance and a relative deficiency of insulin. The onset of T2DM is generally more gradual compared to Type 1 diabetes, and it may go unnoticed for a considerable time, which can lead to long-term complications before a proper diagnosis is made [39]. several significant risk factors contribute to the development of Type-2 diabetes [1]:

Weight: Being overweight is a primary risk factor for type 2 diabetes.

Inactivity: The less physical activity, the greater the risk of Type-2 diabetes.

Family history: The risk of type-2 diabetes increases if a parent or sibling has type-2 diabetes.

Race: Ethnicity is another important factor.

Age: The risk of Type-2 diabetes increases as we get older, particularly after the age of 45.

Diet: It is another important factor due to which diabetes can occur High blood glucose during pregnancy affects the unborn child.

Gestational Diabetes Mellitus (GDM)

It develops at the time of pregnancy due to insulin resistance and subsequent high blood glucose. It is likely to occur about the 24th week of pregnancy [1]. As gestational diabetes usually grows far along in pregnancy, the fetus is already well-formed but is still increasing. The instant threat to the baby is therefore not as severe as for those whose mother had Type-1 diabetes or Type-2 diabetes before pregnancy. Even so, uncontrolled GDM can have solemn values for both the mother and her baby [1].

Complications of Diabetes Mellitus

Complications from diabetes can develop progressively and may ultimately lead to disabling and life-threatening health issues. High blood sugar is associated with a range of diseases that affect the heart, blood vessels, eyes, kidneys, and nerves. Additionally, individuals with diabetes face a higher risk of infections. Diabetes is a leading cause of cardiovascular diseases, blindness, kidney failure, and lower-limb amputations, particularly in high-income countries. The prevalence of type-2 diabetes is also rising in middle- and low-income countries, impacting both individuals and the economy [1].

Diabetes Prevention

Diabetes is the fourth or fifth leading cause of death in high-income countries and also affects industrialized nations. Nearly every country has individuals living with diabetes. Without effective prevention and management programs, this issue could escalate into a global concern [1]. Preventing diabetes involves promoting behavioral changes that modify eating habits and increase physical activity to reduce obesity, along with the use of specific glucose-lowering medications. These interventions are feasible in all nations and cultures [40]. Additionally, Preventing complications should be a primary focus of diabetes treatment. It is crucial to involve patients in the diabetes management team, as this empowers them to take control of their own lives. By participating actively, patients can make important decisions that positively impact their quality of life [40].

Family Involvement in Managing Diabetes

The Role of Family

To fully understand how individuals perceive and manage their health conditions, it is essential to consider the social and family contexts in which these perceptions develop [41]. The influence of family dynamics on health perceptions is particularly important for diabetes management, as most self-care practices occur at home. Evidence from several studies indicates that the opinions of family members about the illness can affect health outcomes. Differences between the perceptions of patients with chronic conditions and those of their spouses can significantly impact patients' adaptability and coping strategies [42]. Physical, psychological, social, and sexual well-being is closely linked to both the patient's and their spouse's perceptions of the identity and consequences of MI [43]. Significant differences have been observed between the views of family members and those of patients regarding Type-2 diabetes [44]. Family members often perceive diabetes as a very serious illness compared to how patients view it, which can significantly impact daily life [45].

Family Interventions in type-2 diabetes

Various studies have highlighted that the role of family factors in diabetes intervention research, particularly in Type-2 diabetes, has often been overlooked [46]. Despite this, recent evidence suggests that including family members in psychosocial interventions for chronic illnesses can lead to improved health outcomes [47]. A systematic review conducted in 2002 examined the involvement of family members in interventions for patients with Type 2 diabetes. The study found significant weight loss in both the control group and the family involvement group. However, it revealed a notable difference in patient management based on gender, with female patients showing greater improvement than males when treated alongside their spouses rather than alone [48].

Relatives Beliefs to Manage Patients' Diabetes

Family connections play a vital role in managing diabetes. Research has shown that lower levels of conflict, balanced attachment, and strong associations, along with effective communication patterns, are linked to better adherence to treatment regimens [55]. Furthermore, higher levels of social support-especially diabetes-related support from spouses and other family members-correlate with improved adherence.56 Social support also helps reduce the negative impact of stress on diabetes management [57]. Studies have demonstrated that positive family relationships, characterized by low levels of conflict and strong communication, lead to better treatment adherence and help alleviate the adverse effects of stress [57].

Self-management plays an important role for treatment of diabetes mellitus as most diabetics provide their own daily care.58 According to research by De Matteo, support from friends and family promotes adherence by encouraging optimism and self-esteem, which can buffer the stress of being ill and reduce patient depression.59 However, some empirical studies have reported that social support can be a significant barrier to patients' self-management [60].

Methods

Study Design

It was a descriptive cross-sectional study design with a quantitative approach to assess the knowledge of self-management regarding diabetes among the relatives of diabetic patients in Dhaka City, Bangladesh. The study was conducted over four months, from July to October 2023.

Study Participants

The study populations were all those Bangladeshi patients (men and women) including their families and relatives. The study involved diabetic subjects, including both Type-1 and Type-2 patients of all genders, who visited the Mohammedpur Swasthoseba Centre as part of the Diabetic Association of Bangladesh, along with their families and relatives.This study was carried out at Mohammedpur Swasthoseba Center under Diabetic Association of Bangladesh. This center is specialized for treatment and management of diabetic patient as well as general patient.

A purposive sampling method was used to select the study sample. The sample size for the study was calculated using the following formula:

$n=z^2pq/d^2$

Where,

N= desired sample size

Z=1.96(for a 95% confidence interval).

P= prevalence=0.85= 8.5%.10

Q=1-p=1- 0.85= 0.15 or 15%

D=0.05(error level 5%) N= (1.96)2×0.85×0.15÷ (0.05)2

N = 188

Due to inadequate time, source, and financial limitation researcher collected 381 samples with the consent of the guide. The sample size was taken 188.

Inclusion and Exclusion Criteria

Inclusion Criteria:

- Relatives of diabetes patients.
- Relatives who were willing to participate.
- Ownership of mobile phones.

Exclusion Criteria

- Relatives of diabetes patients who are unable to read text messages on mobile phones.
- Relatives of diabetes patients who are physically and mentally unfit.

Instruments

A pre-tested, modified semi-structured questionnaire was used to collect the data. The questionnaire was made on the basis of usual misconceptions and issues which patients and their relatives face. According to the specific objectives the variables were identified and an English questionnaire was drafted. The questionnaire included: Section A: General information, general examination, anthropometric measurements (height in centimeters, and weight in kilograms) and disease history of the case. Section B: Belief regarding diabetes. Questionnaire was validated by local expert and was also made in local language.

Data Collection Technique: SMS Group: This group consists of individuals with or without diabetes who receive educational interventions through mobile messaging.

Non-SMS Group: This group includes individuals with or without diabetes who do not receive any interventional messages.

Study Plan: Patients who visited the selected hospital and met the inclusion criteria were enrolled in the study.

- The study involved two groups: the SMS group and the non-SMS group.
- Consecutive subjects were assigned to either the SMS or non-SMS groups.
- Both groups included relatives of the patients.
- Initially, baseline data was collected over one month. Following this data collection, both groups received an educational intervention
- After another month, the SMS Group received educational intervention regarding a healthy lifestyle through SMS messaging.
- Finally, end line data was collected using the same questionnaire as before.

Data Collection Method

- Informed written consent was obtained in the Bangladeshi language prior to the interview, and participants received verbal briefings about the study and its significance.
- Data were collected during both the pre-intervention and post-intervention phases through face-to-face interviews using a structured questionnaire. The same questionnaire was utilized in both phases.
- Each participant took approximately 30 to 45 minutes to complete the questionnaire, which included clinical and anthropometric measurements. Weight, height, and blood pressure were measured using proper tools, while blood glucose levels were obtained from the patient's medical records during the data collection process.

Educational Intervention

This study aims to find out the effect of educational intervention based on knowledge of 325 relatives of patients in the selected hospital.

Methodology of Educational Intervention

At the beginning of the project, baseline data was collected over one month from both SMS and non-SMS groups. After data collection, an education intervention was given to both groups. After one month, educational intervention regarding a healthy lifestyle was given through SMS to the SMS Group. Two messages per day were sent to the SMS Group for two months. At the end, end-line data was collected by using the same questionnaire from both SMS and non-SMS groups. For patients, we provided a free OPD, and for relatives, we called them over the phone.

Data Management and Analysis

Study records, including each volunteer's signed informed consent and other study related documents were kept in a secure area under the supervision of the local supervisor. All study data was recorded on paper-based forms. Data was double- entered into computerized excel file. All personal subject identifiers were removed from the data set and all enrolled subjects were assigned a specific study number. During the data collection process, any modifications made to written forms or documents were indicated by a single line through the erroneous data. The correction was then entered along with the initials and date of the individual who corrected it. After all data was collected, the paper-based forms were signed by the investigator. The data was

subsequently entered into Microsoft Excel from the hard copies of the questionnaires and imported into SPSS version 13.0 (Statistical Package for Social Sciences) for analysis. The variables used in the study included age, gender, years of education, profession, socio-economic status, ethnicity, type of living arrangement, marital status, religion, height, weight, body mass index, systolic and diastolic blood pressure, type of diabetes, family history of diabetes, duration since diagnosis, and the medications used for diabetes and hypertension.

Simple descriptive statistics were used to represent the variables, specifically by calculating frequencies along with percentages or means with standard deviations as needed. To analyze the changes resulting from the intervention, the Wilcoxon signed-rank test was employed, with two-tailed p-values < 0.05 considered significant. The total number of questions answered as 'wrong,' 'partially correct,' or 'correct' was calculated for each respondent and then analyzed for significance before and after the intervention.

Limitation of the Study: The study was conducted solely in an urban center, which may not accurately represent the overall population;

- The questionnaire was not piloted beforehand, meaning that some issues may not have been adequately addressed;
- The duration of both the pre- and post-intervention phases was very limited, which could also affect the results;

Results

Socio-demographic Characteristics of Participants

Table 1 shows the socio-demographic, anthropometric and clinical characteristics of Participants. The mean age of subjects was 34.58±11.91 in SMS group and 31.02±11.51 in Non-SMS group having a significant difference (p=0.008). Number of males was 102 and 64 respectively SMS and Non-SMS groups. Similarly, number of females was 86 in SMS group and 73 in Non-SMS group. In both groups, almost all of the subjects were living with family and were non diabetic; also, majority of them were married. Significant difference between SMS and Non-SMS groups was found in age (p = 0.008), weight (p<0.001), marital status (p=0.003) and years of education (p=0.023).

Table 1: Socio-demographic Characteristics of Participants with Respect to Non-SMS and SMS Groups (n=325)

Variables	Non-SMS group (n=137)	SMS group (n=188)	p-value
Age	31.02±11.51	34.58±11.91	0.008
Gender			
Male	64 (46.7%)	102 (54.3%)	0.179
Female	73 (53.3%)	86 (45.7%)	
Weight (Kg)	61.18±14.80	66.82±13.53	<0.001
Height (cm)	158.02±16.07	161.60±12.48	0.028
Body Mass Index (Kg/)	24.79±6.04	25.74±5.70	0.159
Systolic Blood Pressure (mmHg)	133.70±27.94	133.31±26.03	0.902
Diastolic Blood Pressure (mmHg)	73.62±11.45	72.96±11.22	0.612
Marital Status			
Single	56 (40.9%)	46 (24.5%)	0.003
Married	80 (58.4%)	136 (72.3%)	
Others (Divorced, widow, etc.)	1 (0.7%)	6 (3.2%)	
Years of Education			
≤ 5	15 (10.9%)	20 (10.7%)	0.023
6 to 10	57 (41.6%)	51 (27.1%)	
11 to 14	49 (35.8%)	97 (51.6%)	
> 14 years	16 (11.7%)	20 (10.6%)	
Living Status			
Alone	4 (2.9%)	3 (1.6%)	0.417
Family	133 (97.1%)	185 (98.4%)	
Type of Diabetes			
Type 1	1 (40.0%)	0 (0%)	0.342
Type 2	4 (80.0%)	4 (100%)	
Medications for Diabetes			
Oral Hypoglycemic Agents	2 (40.0%)	0 (0%)	0.056
Insulin	1 (20.0%)	4 (100%)	
Both	2 (40.0%)	0 (0%)	
Hypertension			
Yes	4 (2.9%)	7 (3.7%)	0.671
No	129 (94.2%)	178 (94.7%)	
Do not know	4 (2.9%)	3 (1.6%)	

Data presented as number (percentage) or Mean ±SD, Comparison done by chi- square test for categorical variables and Students't-test for continuous variables, p-value < 0.05 was considered statistically significant.

Pre- and Post-Mean Belief Scores for Relatives

Table-2 shows the comparison between the total pre- and post-mean belief scores of relatives. In beliefs in both SMS and Non-SMS groups, the mean belief score from pre to

post shows a significant change, which is p=0.001 for both; however, the change was higher in the SMS group than in the non-SMS group. The mean difference in the non-SMS group of pre and post is 15.41, while the mean difference in the SMS group of pre and post is 22.53.

Table 2: Belief Scores of the Relatives within the Non-SMS and SMS Groups (n=325)

	Non-SMS Group (n=137)			SMS Group (n=188)			Non-SMS Versus SMS	
	Pre	Post	p-value	Pre	Post	p-value	Pre p-value	Post p-value
Beliefs	48.18±14.79	63.59±15.39		54.09±	76.62			
			0.001	12.89	±7.26	0.001	0.001	0.001

The result is expressed as a parametric test, mean ±SD, and number, whereas it is appropriate. A significant test is performed using the Student's t-test.

Level of Beliefs Distribution among Relatives

Table 3 illustrates the distribution of belief levels among relatives before and after the intervention. Among the 188 relatives in the SMS group, 34 exhibited poor beliefs, 93 had average beliefs, 60 showed good beliefs, and 1 had an excellent level of belief at baseline. In the Non-SMS group, which consisted of 137 relatives, 49 had poor beliefs, 57 had average beliefs, 31 had good beliefs, and none had an excellent level of belief. After the study, a significant change was observed in the SMS group. While there was also a notable change in the Non-SMS group, it was considerably smaller compared to the SMS group, with a p-value <0.0001. A p-value <0.05 was deemed statistically significant. A chi-square test was employed to compare the SMS and Non-SMS groups, while a two-sample proportion z-test was used to analyze the differences in each belief level at both the pre-and post-conditions.

Table 3: Level of Beliefs Distribution among Relatives (n=325)

	Non-SMS Group (n=137)			SMS Group (n=188)			SMS vs. Non-SMS Groups	
Level	Pre	Post	p- value	Pre	Post	p- value	Pre p-value	Post p-value
Poor	49	17		34	0			
	(35.8%)	(12.4%)	<0.0001	(18.1%)	(0.0%)	<0.0001		
Average	57	31		93	8			
	(41.6%)	(22.6%)	0.0008	(49.5%)	(4.3%)	<0.0001		
Good							0.0030	<0.0001
	31	75		60	121			
	(22.6%)	(54.7%)	<0.0001	(31.9%)	(64.4%)	<0.0001		
Excellent	0	14		1	59			
	(0.0%)	(10.2%)	0.0001	(0.5%)	(31.4%)	<0.0001		

Data presented as number (percentage), chi-square, and paired sample t-test were done; p-value < 0.05 was considered statistically significant.

Determinants of Pre- and Post-Beliefs of Relatives: A Linear Regression Analysis

Table 4 shows the coefficients and their statistical significance from a simple linear regression analysis. In this analysis, the dependent variable is the belief score of relatives, while the independent variables include age, marital status, height, weight, and years of education. Two linear regressions were used; one with pre belief score of relatives and other with post belief scores of relatives. The results suggest that each independent variable has no significance impact on belief score of relatives except for 'height'. However, the impact of height on belief scores of relatives in very small.

Table 4: Linear Regression of Pre and Post Belief Scores of Relatives (n=325)

Independent Variable	Pre Beliefs		Post Beliefs	
	β	p-value	β	p-value
Groups (SMS vs. Non-SMS)	-0.092	0.119	-0.475	<0.001
Age (years)	0.196	0.008	0.060	0.372
Gender (Male, Female)	-0.018	0.746	-0.079	0.127
Marital Status (Single, Married, Divorced, Widow)	-0.005	0.944	0.046	0.497
Body mass index (BMI)	-0.109	0.070	-0.066	0.223
Education (Years) (up to 10, >10)	0.266	<0.001	0.137	0.009
Living With (Alone, Family)	0.068	0.237	0.008	0.879
(Constant)		0.025		<0.001

β for standardized regression coefficient, patient's knowledge was taken as dependent variable whereas other taken as independent variables. P-value <0.05 was considered statistically significant. The Frequency Distribution of Relatives' Individual Belief Levels

Table 5 presents the responses from relatives regarding each of the twenty-eight belief-related questions, categorized into two groups: SMS and Non-SMS. The table presents the percentage of correct and incorrect answers both before and after the evaluation.

Table 5: Option Selected for Belief Related Questions by Relatives (n=325)

Option Selected	Non-SMS Group (n=137)		SMS Group (n=188)	
	Pre	Post	Pre	Post
1-3a. The usual cause of diabetes is lack of effective insulin in the body.				
Correct	88 (64.2%)	111 (81.0%)	119 (63.3%)	184 (97.9%)
Wrong	49 (35.8%)	26 (19.0%)	69 (36.7%)	4 (2.1%)
2-3b.Eating too much sugar and other sweet foods is a cause of diabetes.				
Correct	54 (39.4%)	66 (48.2%)	101 (53.7%)	173 (92%)
Wrong	83 (60.6%)	71 (51.8%)	87 (46.3%)	15 (8.0%)
3-3c.High blood pressure is a major cause of diabetes				
Correct	77 (56.2%)	75 (54.8%)	137 (72.9%)	177 (94.1%)
Wrong	60 (43.8%)	62 (45.2%)	51 (27.1%)	11 (5.9%)
4-3d. Diabetes can transfer from husband to Wife or vice versa				
Correct	97 (70.8%)	112 (81.8%)	142 (75.6%)	184 (97.9%)
Wrong	40 (29.2%)	25 (18.2%)	46 (24.4%)	4 (2.1%)
5-4a. The best way to check my diabetes is by testing my urine.				
Correct	74 (54%)	109 (79.6%)	131 (69.7%)	181 (96.3%)
Wrong	63 (46.0%)	28 (20.4%)	57 (30.3%)	7 (3.7%)
6-1b. Diabetes can be cured				
Correct	106 (77.4%)	107 (78.1%)	157 (83.5%)	176 (93.6%)
Wrong	31 (22.6%)	30 (21.9%)	31 (16.5%)	12 (6.4%)
7-2ab. Frequent urination and thirst are signs of low blood sugar.				
Correct	63 (46%)	107 (78.1%)	103 (54.8%)	171 (91%)
Wrong	74 (54.0%)	30 (21.9%)	85 (45.2%)	17 (9.0%)
8-2c. Diabetes causes to reduce hungriness				
Correct	78 (56.9%)	97 (70.8%)	103 (54.8%)	146 (77.7%)
Wrong	59 (43.0%)	40 (29.2%)	85 (45.2%)	42 (22.3%)
9-7a. Medication is more important than diet and exercise to control diabetes.				
Correct	13 (9.5%)	26 (19%)	10 (5.3%)	6 (3.2%)
Wrong	124 (90.5%)	111 (81.0%)	178 (94.7%)	182 (96.8%)
10-4b. Diagnosis diabetes through blood sample is painful and old concept				
Correct	53 (38.7%)	95 (69.3%)	72 (38.3%)	165 (87.8%)
Wrong	84 (61.3%)	42 (30.7%)	116 (61.7%)	23 (12.2%)
11-8a. Those who are diabetic can’t enjoy life like normal people				
Correct	84 (61.3%)	101 (73.7%)	133 (70.7%)	181 (96.3%)
Wrong	53 (38.7%)	36 (26.3%)	55 (29.3%)	7 (3.7%)
12-2e. Blurred vision is the symptom of low blood sugar				
Correct	27 (19.7%)	19 (13.9%)	38 (20.2%)	7 (3.7%)
Wrong	110 (80.3%)	118 (86.1%)	150 (79.8%)	181 (96.3%)
13-10a. Regular exercise can manage diabetes better.				
Correct	109 (79.6%)	116 (84.7%)	172 (91.5%)	177 (94.2%)
Wrong	28 (20.4%)	21 (15.3%)	16 (8.5%)	11 (5.8%)
14-9a. After taking insulin patient become addicted of insulin				
Correct	42 (30.7%)	83 (60.6%)	66 (35.1%)	170 (90.4%)
Wrong	95 (69.3%)	54 (39.4%)	122 (64.9%)	18 (9.6%)
15-9b. Insulin syringe cant reuse				
Correct	60 (43.8%)	106 (77.4%)	99 (52.7%)	179 (95.2%)
Wrong	77 (56.2%)	31 (22.6%)	89 (47.3%)	9 (4.8%)
16-8b. Those who are diabetic can’t participate in sports				
Correct	93 (67.9%)	103 (75.2%)	135 (71.8%)	180 (95.7%)
Wrong	34 (32.2%)	34 (24.8%)	53 (28.2%)	8 (4.3%)
17-9c. One of the most important impact of insulin it damages kidney and heart				
Correct	35 (25.5%)	18 (13.1%)	43 (22.9%)	4 (2.1%)
Wrong	102 (74.5%)	119 (86.9%)	145 (77.1%)	184 (97.9%)
18-7b. Fruit is a healthy food. Therefore, it is ok to eat as much as				
Correct	80 (58.4%)	108 (78.8%)	121 (64.4%)	179 (95.2%)
Wrong	57 (41.6%)	29 (21.2%)	67 (35.6%)	9 (4.8%)
19-7e. Diabetes can control trough starvation				
Correct	96 (70.1%)	112 (81.7%)	153 (81.4%)	177 (94.1%)
Wrong	41 (29.9%)	25 (18.3%)	35 (18.6%)	11 (5.9%)
20-8d. Diabetic male patient can’t lead a normal marital life				
Correct	81 (59.2%)	112 (81.8%)	131 (69.7%)	180 (95.8%)
Wrong	56 (40.8%)	25 (18.2%)	57 (30.3%)	8 (4.2%)
21-7d. People with diabetes should eat special diabetic foods				
Correct	32 (23.3%)	104 (75.9%)	56 (29.7%)	167 (88.8%)

Wrong	105 (76.7%)	33 (24.1%)	132 (70.3%)	21 (11.2%)
22-8c. People with diabetes are more likely to get colds and other illnesses				
Correct	44 (32.1%)	102 (74.5%)	68 (36.0%)	163 (86.7%)
Wrong	93 (67.9%)	35 (25.5%)	120 (64.0%)	25 (13.3%)
23-8e. Diabetic female can't conceive				
Correct	98 (71.5%)	115 (83.9%)	159 (84.6%)	186 (98.9%)
Wrong	39 (28.4%)	22 (16.1%)	29 (15.4%)	2 (1.1%)
24-5a. In hyperglycemia patient feels extreme tiredness				
Correct	115 (83.9%)	131 (95.6%)	174 (92.6%)	188 (100%)
Wrong	22 (16.1%)	6 (4.4%)	14 (7.4%)	0 (0.0%)
25-5d. Hyperglycemic patient usually suffer from acidity				
Correct	17 (12.4%)	88 (64.2%)	20 (10.6%)	171 (91%)
Wrong	120 (87.6%)	49 (35.8%)	168 (89.4%)	17 (9.0%)
26-6c. Blurred vision is in main symptom of hypoglycemia				
Correct	80 (58.4%)	115 (83.9%)	141 (75%)	186 (98.9%)
Wrong	57 (41.6%)	22 (16.1%)	47 (25.0%)	2 (1.1%)
27-6b. Morning headaches are also symptoms of night time hypoglycemia				
Correct	55 (40.1%)	101 (73.7%)	105 (55.9%)	184 (97.9%)
Wrong	82 (59.9%)	36 (26.3%)	83 (44.1%)	4 (2.1%)
28-10b. Diabetic patient can't participate in games and athletics				
Correct	76 (55.5%)	58 (42.4%)	99 (52.6%)	96 (51.1%)
Wrong	61 (44.5%)	79 (57.6%)	89 (47.4%)	92 (48.9%)

Data presented as number (percentage).

Discussion

Diabetes related beliefs were found significantly to be improved in relatives after SMS-based educational intervention. Pre and post assessment of belief on sign & symptoms and as well as management of diabetes were performed. Significantly improved knowledge was observed after the intervention in relatives ($p<0.001$). To the best of our knowledge, this study is the first ever on diabetes related belief for measuring the impacts of mobile SMS in relatives. After the intervention we found that belief was increased both among participants who received and did not receive SMS based education. However, diabetes related belief was significantly higher in participants who received SMS compared to the participant who did not receive SMS ($p<0.001$). Pre- and post-mean difference of knowledge scores in participants who received and who did not receive SMS were 41.46 and 15.11 respectively ($p<0.001$).

The findings are found in line with a recent study from India, where it has been chosen that mobile SMS is generally well accepted and it is an effective technique for lifestyle modification [29]. The numbers of relatives in Non-SMS group are 137 and in the SMS group are 188. Similar kind of uneven case and control group found in different studies [62-63]. Education and living status of the patients in the non-SMS and SMS groups were significantly different (p=0.04 & p=0.039 respectively). We found that age weight and marital status of the patients relatives were significantly different between the groups ($p<0.008$, $p<0.001$ and $p<0.005$ respectively). Analysis from pre and post assessment of knowledge and belief related responses from patients and relatives reveled significant improvement ($p<0.001$). We found that knowledge of the relatives in Non-SMS and SMS groups were significantly increased after the intervention. In SMS group knowledge was significantly changed; however the change was very small in the non-SMS group compared to the SMS group. We also analyzed the impact of knowledge adjusting the confounding variables in a multivariate model. Education and SMS were found to be most important variables which impact the knowledge of the relatives. To validate the impact of belief in Non- SMS and SMS group we have not found any strong relation. We observed that young people's beliefs are positively stronger among relatives.

To validate our findings we compared between total pre and post mean belief scores of relatives. Between SMS and Non-SMS groups in relatives, the mean belief score from pre to post, shows a significant change (p=0.001). However, the change was higher in SMS group compared to the Non-SMS group. The mean difference in Non- SMS group between pre and post is 14.46 while that in the SMS group is 21.48. However, the change was higher in SMS group compared to the Non-SMS group. The mean difference in Non-SMS group between pre and post is 17.1 while that in the SMS group is 41.86. The mean difference in the Non-SMS group between pre and post is 15.41 while that in the SMS group is 22.53. Similar results related to impact of knowledge education were also found in a study by Hee Yun Lee [64].

This hospital based diabetes education intervention study describes to measure the effects of mobile phone SMS among diabetic subjects and their relatives. One of the most significant barriers to diabetes management is the lack of awareness and education about the disease. Different studies already available, show that primary prevention is needed to control the rising trend in the prevalence of diabetes.65 Short message service (SMS) is a substitute technique for dissemination of educational guidance and motivation to attain lifestyle modification in primary prevention [22]., it is also useful for patient compliance. In recent years there are numerous attempts to integrate mobile phones for health interventions and this study can direct future research in Bangladesh for diabetes prevention and management using the innovative mobile technologies. Due to the time and budget constrain we limit our study to a single diabetic center; however, it still provides valuable indications regarding the effectiveness of the strategy.

Conclusion and recommendations

Conclusion

Data from the present study leads to the following conclusions:

- Whether education traditional or technology based itself has significant impact on improving the belief status of relatives;
- SMS based continuous education using a mobile phone significantly increases the effectiveness on traditional education to improve belief regarding diabetes mellitus among relatives;
- Relatives who have higher BMI in both Non-SMS and SMS group, their prior belief about diabetes was higher;

Recommendations

- SMS based education, with targeted messages, should be recommended to relatives to improve their belief regarding the disease.
- Larger scale studies, especially at community levels, should be designed to assess a more general effectiveness of the technique as well as to evaluate the determinants and cost-effectiveness of the strategy.

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