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The Effectiveness of Educational intervention based on Health Belief Model Delivered via WhatsApp on Oral Health Knowledge and Behaviors of individuals with Type 2 Diabetes Mellitus; A Randomized controlled Trial

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## ABSTRACT

### **Background:**

Oral health is essential for overall wellbeing, particularly for those with chronic conditions like Diabetes Mellitus. Individuals with Diabetes face a higher risk of developing oral health complications, yet many lack adequate knowledge and proper practices to manage their oral health. Social media offers a potential platform for health education and can improve health behaviors. However, the effectiveness of using theory-based education, such as the Health Belief Model, through platforms like WhatsApp to improve oral health knowledge and behavior among individuals with diabetes remains underexplored.

### **Objectives:**

This study aims to evaluate the effectiveness of a HBM based educational intervention delivered through WhatsApp in enhancing oral health knowledge and behaviors among individuals with Type 2 diabetes, compared to a control group receiving oral health education through educational brochure.

### **Methods:**

This study utilized a quantitative randomized controlled trial approach with an intervention group and a control group. The Data were collected at baseline and one-month post-intervention. The intervention group was provided with oral health education through WhatsApp videos based on the HBM, while control group received an educational brochure. Participants' oral health knowledge and behaviors were evaluated using a detailed questionnaire. Statistical analysis was performed to evaluate changes in the knowledge and behaviors of both groups over the study period.

**Key Words:** Diabetes Mellitus, oral health, Health Belief Model, WhatsApp, knowledge, behaviors, educational intervention, social media

# INTRODUCTION

## Background

Diabetes Mellitus is a chronic metabolic disease characterized by hyperglycemia which is caused by a defect in insulin secretion, function, or both. This condition often leads to complications such as retinopathy, kidney failure, coronary artery disease, poor wound healing, foot numbness, as well as oral diseases.(1,2). Even though there are no particular oral lesions linked to diabetes mellitus but persistent uncontrolled hyperglycemia can produce oral symptoms like burning in the oral mucosa, xerostomia, dental caries, and periodontal disease (gingivitis and periodontitis), which can lead to tooth loss. Diabetes and periodontitis exhibit a bidirectional relationship, where each condition can exacerbate the other.(3) Interestingly diabetes can also be screened for using periodontal disease. According to intervention studies, treating periodontal disease may help glycemic control of individuals with diabetes and, eventually, their general health.(4)

As of 2019, there were 463 million people worldwide with Diabetes Mellitus, or 9.3% of the total population. It is predicted that this percentage will increase drastically to 10.9% (or 700 million people) by 2045.(5) Pakistan holds the third position in global diabetes prevalence. In Pakistan, more than 19 million people have diabetes.(6)

A recent study conducted in Pakistan found that while most individuals with diabetes were aware of other complications of diabetes, such as foot ulcers and retinopathy, very few participants were aware of the oral manifestations. This could be caused by the failure of the doctors to provide oral health counseling or by patients' carelessness with regard to routine dental checkups.(4)WHO states that the mainstay of diabetes therapy is education. Indeed, studies have demonstrated that education is useful in controlling diabetes, and that appropriate educational training can lower 80% of diabetic complications.(7)

According to research, although oral health education increases knowledge, it rarely results in long-lasting behavioral changes. The limited success of traditional health education has raised concerns about the knowledge-attitude-practice model, which has led to an investigation of psychological theories in an effort to better explain health behaviors.(8) One of the earliest behavior analytic models, The Health Belief Model has been applied to many studies on health

behaviors, including type 2 diabetic mellitus (T2DM).(7) At present HBM is one of the most extensively adopted theories used to develop health behavior modifying interventions .(9) The HBM, was formulated by social psychologists in the 1950s, its purpose was to understand and predict individuals' engagement in preventive health behaviors. According to this model, to incorporate improved oral health practices, Individuals with diabetes must first perceive themselves as susceptible to oral complications and recognize the severity of these complications. Additionally, they should understand the benefits of oral healthcare and have the self-efficacy to overcome the barriers, while also being influenced by internal and external cues to action that inspire them to prioritize oral health. (7)

Digital technological advancements, especially social media, have revolutionized public health communication. These platforms are useful for promoting public health since they are accessible, cost effective, and improve retention of information. Patients, particularly those with diabetes, can interact, exchange stories, and enhance their self-management using social media.(10)

## **Significance of the problem**

Oral health receives limited attention in diabetes management, despite the fact that diabetes contributes to serious oral health complications. The purpose of this study is to use an educational intervention based on HBM to improve oral health awareness which encourage healthy behaviors among individuals with diabetes. Although HBM has been effectively used in earlier studies to improve health outcomes, this study intends to investigate its efficacy via social media, specifically WhatsApp. WhatsApp enables the easy, accessible and engaging communication which makes it an important delivery platform. This study aims to assess the effectiveness of an intervention (educational content delivered via WhatsApp) in improving oral health knowledge among individuals with T2DM.

## **Objectives of the study**

The objectives of the study are to evaluate the impact of a WhatsApp-based HBM intervention on oral health knowledge and behavior of individuals with T2DM and to compare the effectiveness of WhatsApp based education with the education given via brochures.

## **Hypothesis**

Adults having T2DM who acquire HBM based educational intervention regarding oral health through WhatsApp will show a significant improvement in oral health knowledge and behaviors, as compared to those who receives the educational brochure.

## **Operational Definitions**

### **Oral Hygiene-Related Behaviors:**

Participants' reported frequency and quality of oral health practices, including brushing, flossing, gingival health, and dental visits, measured on a scale of 0(never) to 4(always) using performance related questions. Higher scores will indicate better oral hygiene related behaviors. Pre and post intervention scores were compared, and cutoff levels were determined using the mean and standard deviation (SD).(7)

### **Perceived Susceptibility:**

How much diabetic patients think they might get oral health complications, measured using a Likert scale. (1 = Strongly Disagree to 5 = Strongly Agree). Higher scores reflect a greater perceived susceptibility. Pre and post intervention scores were compared, with cutoff levels based on the mean  $\pm$  SD. (7)

### **Perceived Severity:**

Participants' perceptions of the severity of oral health complications and their potential impact on their overall wellbeing and diabetes management. Assessed through Likert scale statements rated from 1 (Strongly Disagree) to 5 (Strongly Agree). Higher scores indicate greater perceived severity. Pre and post scores will be compared using the mean and SD as cutoff criteria.(7)

### **Perceived Benefits:**

Participants' beliefs about the positive outcomes of engaging in oral hygiene behaviors, such as prevention of oral complications. Assessed using Likert-scale items from 1 (Strongly Disagree) to 5 (Strongly Agree). Higher scores reflect

stronger perceived benefits. Pre and post intervention scores will be compared, and categorization will be done using the mean and SD. (7)

#### **Perceived Barriers:**

Perception of participants about different challenges that hindered their ability to maintain proper oral hygiene. These self-reported barriers consist of financial constraints, time constraints, and insufficient knowledge or awareness about oral health care. Measured using items rated from 1 (Strongly Disagree) to 5 (Strongly Agree). Higher scores represent greater perceived barriers. Pre- and post-scores will be compared, with cutoffs based on mean  $\pm$  SD. (7)

#### **Self-Efficacy:**

Confidence in performing and maintaining oral hygiene behaviors. It will be assessed via Likert scale items scored from 1 (Strongly Disagree) to 5 (Strongly Agree). Higher scores indicate greater self-efficacy. Pre- and post-intervention results will be compared, with cutoff scores determined by mean and SD. (7)

#### **Cues to Action:**

Factors which include both Internal and external that motivate participants to involve in oral hygiene behaviors, such as family encouragement or healthcare provider advice. Assessed using a Likert scale. Higher scores denote stronger cues to action. Comparison of pre and post scores were done using the mean and SD for cutoff classification. (7)

#### **Awareness:**

The participant's knowledge about the relationship between diabetes and oral health issues, assessed through binary questions (Yes = 1, No = 0). Higher scores reflect higher awareness levels. Pre and post awareness scores will be compared, and cutoff scores will be calculated using the mean and SD. (7)

### **Health Belief Model Constructs:**

A theoretical framework which consists of perceived susceptibility, severity, benefits, barriers, self-efficacy, and internal and external cues to action, used to explain and predict oral hygiene behaviors.(7)

## **CHAPTER 2**

### **REVIEW OF LITERATURE**

In relation to the oral health status among individuals with diabetes, Oktawati et al. (2024) observed that nearly half of individuals with diabetes presented with poor oral hygiene, with many diagnosed with gingivitis or periodontitis. Improved periodontal status was directly correlated to better oral health knowledge, which emphasizes the essential role of awareness in managing oral health among individuals with diabetes.(3) Sairat and Phoosuwan (2024) also reported poor oral health behaviors in individuals with diabetes , with an average Decayed, Missing, and Filled Teeth (DMFT) index of 10.6 and irregular tooth brushing. They found that higher oral health literacy, positive attitudes, and regular visits to the dentist were associated with improved behavior.(2)

A scoping review was done by (Poudel et al., 2022) who explored oral health knowledge and practices of individuals with diabetes in South Asia based on literature search from January 2000 to December 2021. Many participants did not know about the relationship between diabetes and oral health and reported that general practitioners do not provide enough information about oral health. This highlights the necessity of awareness raising initiatives. Furthermore, the participants stated that they would want to know more about oral health, especially from medical professionals like dentists and doctors. This review highlights the importance of making oral health education a fundamental part of diabetes care.(11)

Khan et al. (2022) investigated the relationship between poor oral health and patients with T2DM in Pakistan. They found a significant connection between poor oral health and uncontrolled blood glucose levels as well as longer duration of disease. The study highlighted the need to improve oral health awareness and management in this population.(4) A cross-sectional descriptive survey, conducted by (Islam et al., 2021) through self-administered questionnaires on 400 participants with

diabetes at Abbasi Shaheed Hospital, which is the largest government hospital in Karachi, Pakistan revealed that the connection between diabetes and periodontal disease were not well understood by participants. Several participants did not practice recommended oral hygiene practices, such as brushing and flossing. A significant number visited dentists only rarely, due to their busy schedule or financial difficulties. Most participants prefer Television for information related to risk factors, to maintain good health. In order to improve diabetic patients' knowledge and awareness of periodontal risk and encourage good oral health practices, the study highlights the need for targeted educational interventions. (12)

Barriers to providing comprehensive oral health care for individuals with diabetes has also been addressed by Poudel et al. (2020) who found out in his research that while general practitioners know the importance of oral health, their involvement was often limited to encouraging dental appointments and basic recommendations. Challenges such as time limitations, complicated referral processes, and insufficient training hindered effective collaboration between general practitioners and dental professionals. The study suggested that simplified referrals and improved training can better integrate oral health into diabetes management.(13)

Oral health and Diabetes are closely related, making targeted interventions important to address oral health problems in this population. Malekmahmoodi et al. found that an educational intervention based on the HBM improved oral hygiene practices among individuals with T2DM, with the intervention group showing statistically significant improvements as compared to the control group.(7) Similarly, Sowmya and Sangavi (2024) reported a 61% improvement in oral health outcomes after oral health education intervention, highlighting the value of educational programs in providing comprehensive care for individuals with diabetes.(5)

Building on these findings, Haghdoost et al. demonstrated that social media-based interventions were better than traditional pamphlet or routine-based methods in enhancing oral health awareness.(10) Regardless of patients' health literacy levels, diabetes education through WhatsApp showed promising results, according to a randomized, two-arm parallel interventional study conducted by Al Omar, Hasan, Palaian, & Mahameed, in 2020 with a 6-month patient follow-up that evaluated the effect of a patient centered diabetes education program delivered via WhatsApp on glycosylated hemoglobin (HbA1c) values. (14)



Extending the discussion of interventions, Mesbahi and Aleksejuniene (2024) used the HBM to guide an SMS based reminder strategy aimed at improving oral health behaviors among adolescents. This intervention, comprising educational sessions and text message reminders, significantly enhanced oral self-care practices and increased duration of tooth brushing. A 100% participation rate underscored the feasibility and acceptability of this approach.(9)

In spite of the well-recognized oral health challenges faced by individuals with diabetes, there are noticeable gaps in Pakistan to address these challenges. The lack of awareness and poor adherence to oral health practices among individuals with diabetes has been documented in researches like that of Islam et al., 2021 and Khan et al. (2022).(4,12) Despite this, very few studies offer actionable strategies to improve oral health behavior among people with diabetes. Theory based interventions like HBM, have proven effective in shaping health interventions globally, but they are seldomly used for oral health education in Pakistan. Using WhatsApp, a widely accessible and familiar platform, this study aims to fill the gaps by encouraging lasting improvements in oral health behaviors among individuals with diabetes.

## **CHAPTER 3**

### **METHODOLOGY**

#### **Study Design**

This study utilized a quantitative, randomized controlled trial approach to evaluate the impact of a HBM based educational intervention delivered through WhatsApp on oral health knowledge and behaviors among adults with T2DM. Participants were randomly assigned into two groups: an intervention group that received HBM-based education and a control group that received an educational brochure that includes information on oral health.

#### **Study Population/Settings**

The study population includes patients with a confirmed diagnosis of T2DM, verified through diabetes clinic records, who are regular attendees at National

institute of diabetes and Endocrinology at Dow University of Health Sciences Karachi.

### **Sampling Technique and Randomization**

A convenience sampling technique was used to recruit participants from the outpatient diabetes clinic at DUHS. Patients who are present at the clinic for their routine appointments and meet the eligibility criteria was approached. They were informed about the study objectives and procedures, and those who agreed to participate was asked to provide written informed consent. After enrollment, participants were randomly assigned to either the intervention group or the control group, following a 1:1 allocation ratio. The randomization process was stratified based on three key characteristics including gender, educational level, and duration of diabetes, to ensure balanced distribution and to minimize potential bias.

Randomization was conducted using random number generator where each participant was assigned a random number, then participants were allocated equally into either Intervention Group which received HBM based education via WhatsApp or control Group which received an educational brochure. This study was single blinded in which participants were not informed about the presence of two distinct groups; they were only aware about receiving education related to oral health.

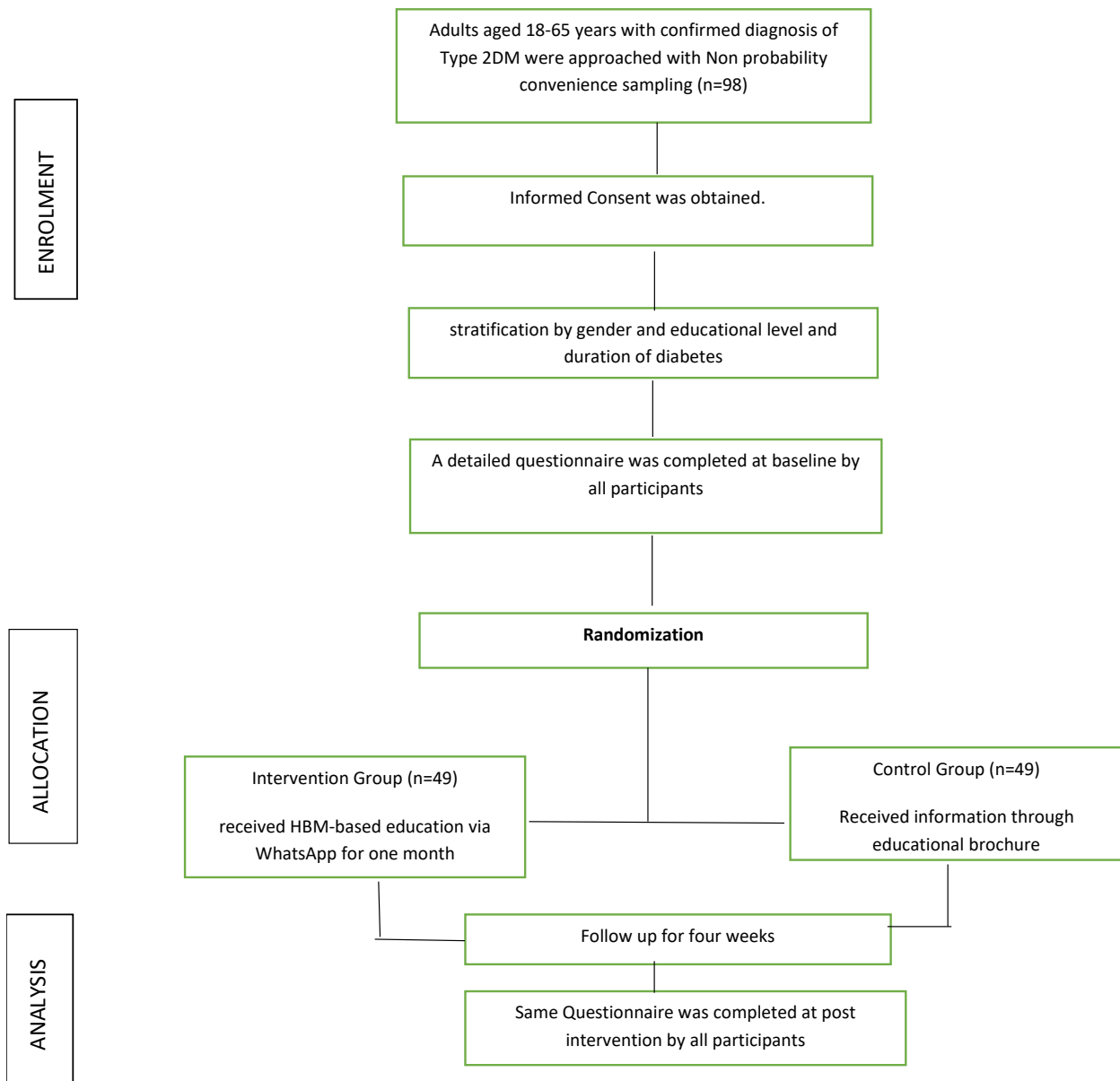


Figure 3.1. Flow diagram of patient selection and allocation into intervention and control groups

## Sample Size

Sample size was calculated using OpenEpi online software, based on two independent sample t-test by using mean and standard deviation of post intervention perceived susceptibility score

which were  $4.09 \pm 0.49$  in intervention group and  $3.64 \pm 1.01$  in control group in the study conducted by Malekmahmoodi et al. (2020)(7). A sample size of 49 achieved in each group, power 95% with a significance level (alpha) of 0.01. Total 98 patients have been recruited and divided into 49 patients in each group (two groups).

### **Study Duration From date to date**

The study was conducted from July 2025 to December 2025, including participant recruitment, the delivery of the educational intervention, and the completion of post intervention assessments.

### **Inclusion Criteria**

- Adults aged 18-65 years with a confirmed diagnosis of T2DM
- Able to use WhatsApp for the study duration
- Able to read and write in Urdu

### **Exclusion Criteria**

- Edentulous
- Individuals diagnosed with life-threatening diseases such as advanced cancer, end-stage renal disease, or severe cardiac failure
- Diminished cognitive ability
- Radiotherapy in head and neck region.
- Planning to migrate during the study period.

### **Ethical Considerations**

Ethical approval was obtained from the Institutional Review Board (IRB) of Dow University of health sciences prior to data collection. (IRB-4057/DUHS/Approval/2025/294)

### **Data Collection Procedure**

Data were collected using a self-reported questionnaire delivered at two points: baseline (before intervention) and one-month post-intervention, to assess changes in oral health knowledge and behaviors.

At baseline, a detailed questionnaire was completed by all the participants. The intervention group then received educational training based on the HBM through WhatsApp videos, while the control group was provided with an educational brochure containing information related to oral health. Over a period of one month, participants were followed to monitor any changes.

1-month follow-up aligns with Mesbahi and Aleksejuniene's (2024) strategy, where an initial 5-week follow-up assessed the efficiency of the intervention(9). At the end of this period, the questionnaires were again completed by both groups.

## **Survey Instrument**

A structured, close-ended and self-reported questionnaire with a five-point Likert scale was used. The questionnaire was designed to measure HBM constructs (e.g. perceived susceptibility, severity, benefits, barriers, cues to action, and self-efficacy), awareness of oral health and oral hygiene related behaviors. A panel of four subject matter experts reviewed the instrument, including two dentists, a public health specialist and an endocrinologist. Each expert independently evaluated the questionnaire items by using a four-point relevance scale, ranging from "not relevant" to "highly relevant." Their ratings were used to calculate content validity indices, Items with poor expert agreement ( $I-CVI \leq 0.25$ ) were removed, while items with minor disagreement ( $I-CVI = 0.75$ ) were revised for clarity. Items with strong relevance ratings ( $I-CVI = 1.00$ ) were retained as it is in the final questionnaire. The S-CVI/Ave for the final instrument was 0.89, which indicates good content validity. The universal agreement index (S-CVI/UA) was 0.83, indicating that 83% of the items received unanimous relevance ratings from all four experts.(15)

The final questionnaire consisted of three major sections, designed to assess oral-health knowledge, HBM constructs, and behaviors among individuals with Type 2 Diabetes. Section I comprised of 10 items assessing oral-health knowledge. Section II included the HBM constructs, which was subdivided into

seven domains: Perceived Susceptibility (7 items), Perceived Severity (10 items), Perceived Barriers (6 items), Perceived Benefits (6 items), Self-Efficacy (7 items), Internal Cues to Action (4 items) and External Cues to Action (5 items). Section III was focused on oral-hygiene behaviors, comprising 10 items which measured the frequency and consistency of participants' oral-health behaviors.

The Cronbach's alpha value of the final instrument was calculated after the pilot study in which 30 participants filled the questionnaire which was 0.783. (16)

## **Scoring**

The awareness questions section was scored such that each correct answer received 1 point, and each incorrect answer received 0 points. The total score for the awareness section was calculated based on maximum score of 10. The HBM constructs were assessed using five-point Likert scale, with response options ranging from "strongly agree" to "strongly disagree" and scored from 1 to 5, respectively. The scores for each model construct were calculated and reported within the range of 1 to 5. Similarly, the behavior questions were scored on a 5-point Likert scale of behavior evaluation, with responses ranging from "never" to "always" and scored from 0 to 4. In this study, higher scores indicate higher levels of awareness, perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, self-efficacy, and performance of oral hygiene practices among diabetic patients.

## **Intervention**

The intervention consisted of a four-week WhatsApp-based oral health education program based on HBM. The WhatsApp based intervention consisted of 12 short educational videos, each approximately 3 to 5 minutes in duration, these videos were sent individually to each participant every alternate day from Monday to Friday, resulting in three videos per week over a period of one month, Reminders were sent the following day after each video to encourage engagement and

sustain behavior change. Each week was focused on specific HBM constructs delivered through short, professionally scripted educational videos in Urdu.

In Week 1, participants were introduced to the link between diabetes and oral health and the importance of maintaining good oral hygiene. Week 2 focused on perceived susceptibility and severity by highlighting the increased vulnerability of diabetic patients to oral complications and the consequences of poor hygiene practices. Week 3 addressed perceived benefits, perceived barriers, and cues to action by explaining how adopting oral-health behaviors can reduce complications, improve comfort, and minimize treatment costs, while also identifying common challenges and strategies to overcome them. Week 4 strengthened perceived self-efficacy by demonstrating correct oral-care techniques, such as brushing technique, flossing, tongue cleaning, and gum massage, enabling participants to confidently perform these behaviors independently.

All educational materials underwent expert review by dentists, public health specialist and Endocrinologist prior to implementation to ensure clarity, cultural sensitivity, and scientific accuracy. Adherence to the intervention was monitored through WhatsApp by sending follow-up messages and engaging reminders. The control group received only a printed brochure containing basic oral-health information and routine care during the study period. However, after the study concluded, the control group was also provided access to the same educational videos to ensure ethical equity and allow them to benefit from the intervention content.

**کیا آپ جانتے ہیں؟**

شوگر اور مسوڑھوں کی بیماری کا دو طرفہ تعلق ہے۔ زیادہ شوگر مسوڑھوں کی سوزش بڑھاتی ہے، اور مسوڑھوں کی سوزش شوگر کنٹرول کو مشکل بنادیتی ہے۔

**ذیابیطس اور منہ کی صحت**

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**”ایک اہم تعلق“**

**صحت مند منہ، بہتر زندگی**

**ذیابیطس کے مریضوں میں منہ کی صحت کے مسائل**

- مسوڑھوں کی سوجن اورخون آنا
- دانتوں کا ہلنا
- خشک منہ
- زخم کا دیر سے بھرنا
- منہ کے انفیکشنز
- دانتوں میں کیڑا

**منہ کی صحت کے لئے آسان اقدامات**

روزانہ دو بار برش اور فلووس کریں  
سال میں کم از کم ایک بار دانتوں کا معائنہ کروائیں  
تمباکو نوشی سے پرہیز کریں  
متوازن غذا کھائیں، کم شکر استعمال کریں  
ذیابیطس اور منہ کی صحت کے درمیان تعلق کو سمجھیں

**بروقت احتیاط، مہنگے علاج سے نجات**

تحقیقات سے ثابت ہوا ہے کہ ذیابیطس کے مریضوں میں مسوڑھوں کی بیماری (پیریوڈنٹائٹس) ہونے کا خطرہ تقریباً تین گنا زیادہ ہوتا ہے۔

روزانہ دانت صاف کرنا مہنگے اور تکلیف دہ علاج سے بچنے کا آسان طریقہ ہے۔

وقت پر منہ کی صفائی اور چیک اپ سے شوگر کے مریض بڑی پیچیدگیوں سے محفوظ رہ سکتے ہیں

**8 STEPS for healthy teeth**

Figure 3.2: Educational brochure given to the control group, containing oral-health information related to diabetes mellitus.



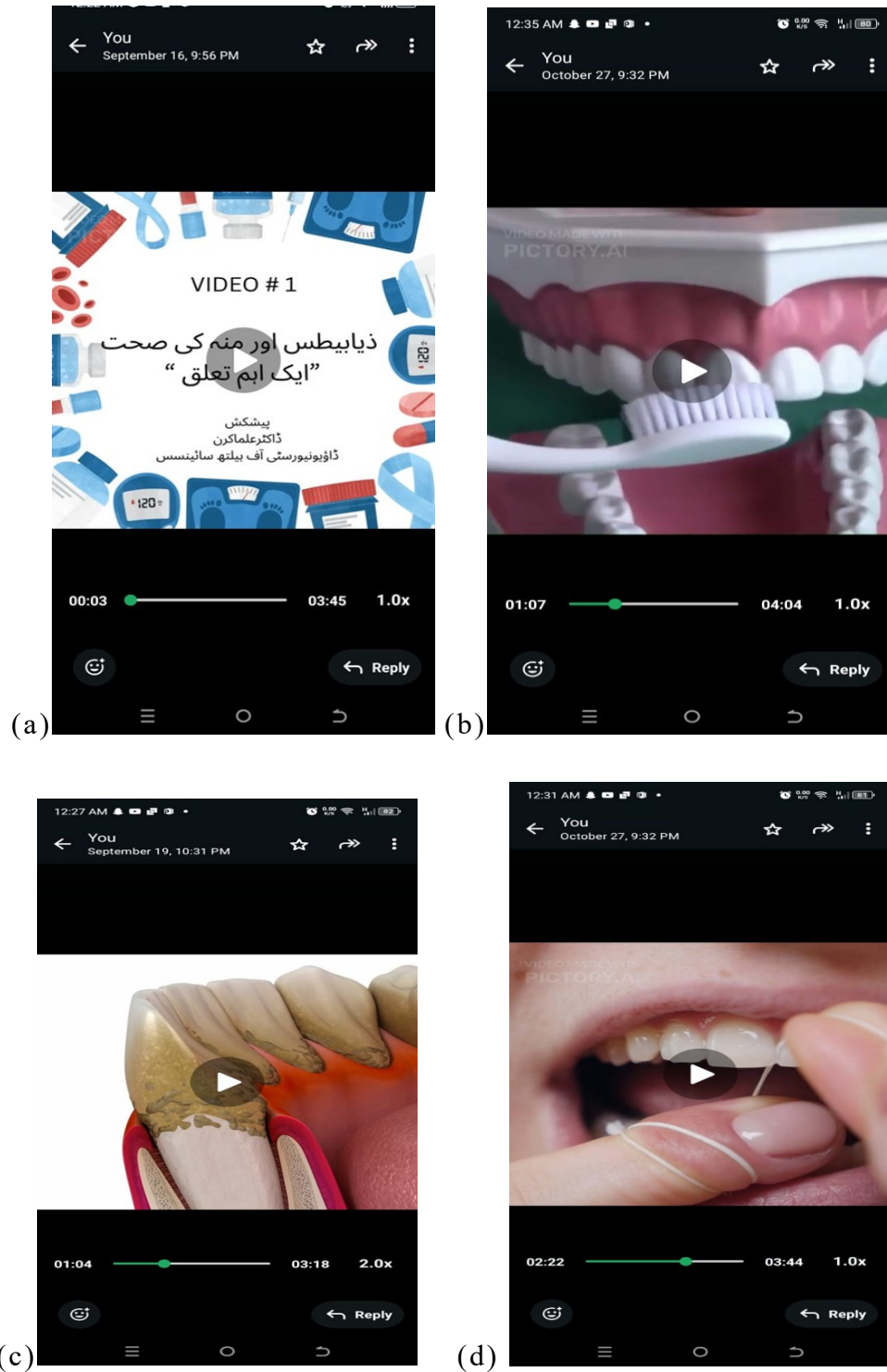


Figure 3.3: Some Screenshots from oral-health educational intervention videos shared via WhatsApp, illustrating a. demonstrations of link between diabetes and oral health, b. proper brushing technique, c. oral complication of diabetes and d. flossing technique.

## Data Analysis Procedure

Data were analyzed through a statistical package for Social Sciences (SPSS) version 26. Frequency and percentages were reported for qualitative variables. Mean and standard deviations were reported for normally distributed quantitative variables while median and interquartile ranges were reported for non-normally distributed quantitative variables. Normality of quantitative variables were assessed using Shapiro-wilk's test of normality. The Independent sample t-test was conducted to compare the mean scores of perceived barriers and behavior between the intervention and control groups. For all other constructs, which were not normally distributed, the Mann-Whitney U test was applied. For within-group comparisons of pre and post scores of behaviors and perceived barriers, the Paired sample t-test was used. The Wilcoxon signed rank test, was used for the remaining variables that were not normally distributed. Stratification was carried out based on gender, diabetes duration, and education level to see the effect of these modifiers on outcome (control vs. intervention) using Chi-square test. A p value less than and equal to 0.05 was considered as significant.

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