

**Impact of Health-Related Twitter Messages on Rates of Diabetes Screening in the
Saudi Arabian Population**

Hossam Alakhrass

Imperial College London

Department of Public Health

Doctor of Philosophy

Declaration of Originality

I, Hossam Alakhrass, declare that this document reflects my own work. Other written works used as references are properly cited throughout the document.

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Dedication

I would like to dedicate my project and this completed dissertation to my late father, Dr. Kamal, to my endlessly loving and always supportive mother, and to my brother and sisters.

Acknowledgement

It is with humility that I express my extreme gratitude for some exemplary individuals and organizations who graciously assisted me with my project. First, I would like to thank my colleagues at the National Diabetes Prevention and Control Program (NDPCP) at the Saudi Arabia Ministry of Health who completely supported me in my project, and guided me along the way. This project would not have been possible without their help and mentorship.

Second, I would like to thank my dissertation committee and my advisor, who have guided me from day one of this project. They directed me in all my tasks and writing, and provided many hours of feedback. I thank them for their dedication to working with me through the entire process to graduation.

Third, I would like to thank some people I look up to for their vision and guidance through this entire process, most specifically Dr. Abdullah Assiri and Dr. Fatima Al Slail at the Saudi Arabia Ministry of Health.

Concise Abstract

Problem Domain: Type II diabetes (T2D) is a severe chronic metabolic disorder. The Kingdom of Saudi Arabia (KSA) currently suffers from high rates of undiagnosed T2D. In response, the KSA Ministry of Health (MoH) implemented the National Diabetes Prevention and Control Program (NDPCP) as a way to promote the diagnosis and early intervention for T2D. This project aimed to assess the feasibility of using Twitter, a highly-used social media platform in KSA, to promote diabetic screening among persons at risk of developing T2D in KSA. The objectives of this research were to: 1) develop a targeted social media model for the “Do not Wait for Diabetes” (DNWD) Campaign using Twitter, 2) compare the screening frequencies for T2D before and after the implementation of the DNWD Twitter Campaign, 3) measure users’ engagement and satisfaction with the DNWD Twitter Campaign, and 4) explore stakeholders’ views on the DNWD Twitter Campaign and its wider implementation and sustainability.

Methodology: To achieve the objectives, a Twitter social media campaign was implemented using the MoH NDPCP Twitter account, and three substudies performed. Frequencies of T2D referrals at two MoH clinical locations, results from a Twitter user survey, and qualitative data from interviewing clinical and governmental stakeholders were analyzed to provide insight on the impact of the Twitter social media campaign.

Results: The social media campaign was implemented from November 2017 through July 2018. Referral data were not helpful in providing insight on campaign impact, but survey data were. Of the approximately 800 Twitter users surveyed who were following the NDPCP Twitter account, 95% of respondents reported getting screened for T2D over the period of the campaign, and of those, 87% said they were

motivated by the tweets from the campaign. Over 90% of respondents reported satisfaction with various dimensions of the tweets. Interview results revealed that stakeholders felt that the campaign was realistic and sustainable if budgeted as a component of the overall public health campaign organized by the MoH.

Conclusion: This project demonstrated that social media can be used to enhance the reach of an existing government-sponsored T2D awareness public health campaign. Future social media health education awareness projects can use this example as a prototype for applying social media to public health campaigns aimed at other clinical areas and populations.

Abstract

Problem Domain: Type II diabetes (T2D) is a severe chronic metabolic disorder. The Kingdom of Saudi Arabia (KSA) currently suffers from high rates of undiagnosed T2D. The KSA Ministry of Health (MoH) implemented the National Diabetes Prevention and Control Program (NDPCP) to promote diagnosis and early intervention of diabetes. This project aimed to assess the feasibility of using Twitter to promote diabetic screening among persons at risk of developing T2D in KSA. The objectives of this research were to: 1) develop a targeted social media model for the “Do not Wait for Diabetes” (DNWD) Campaign using Twitter, 2) compare the screening frequencies for diabetes before and after the implementation of the DNWD Twitter Campaign, 3) measure users’ engagement and satisfaction with the DNWD Twitter Campaign, and 4) explore stakeholders’ views on the DNWD Twitter Campaign and its wider implementation and sustainability.

Methodology: An advisory committee of clinicians at the NDPCP was assembled, and the researcher was guided in developing a targeted social media model for the DNWD Campaign on Twitter. A survey was conducted with almost 800 respondents who were followers of the NDPCP Twitter account. Twelve stakeholders were interviewed from the KSA diabetes clinics, and a thematic analysis was conducted.

Results: The social media campaign was implemented from November 2017 through July 2018. The survey found that 95% of respondents reported getting screened for T2D, and of those, 87% said they were motivated by the tweets from the campaign. Stakeholders felt that the DNWD Twitter Campaign was realistic and

sustainable as long as social media campaigns in general are budgeted as a component of the overall public health campaign organized by the MoH.

Conclusion: This project demonstrated that social media can be used successfully to enhance the reach of an existing government-sponsored diabetes awareness public health campaign.

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1.0 Introduction

1.1 Project Overview

Type II diabetes (T2D) is a severe chronic metabolic disorder, and the Kingdom of Saudi Arabia (KSA) currently suffers from high rates of undiagnosed diabetes (1–3). The Saudi Arabians are also high-intensity users of social media, especially Twitter (4). There are limited barriers to healthcare access to government clinics in KSA (5), however the population is unaware of the necessity to prevent or diagnose diabetes. The KSA Ministry of Health (MoH) has implemented the National Diabetes Prevention and Control Program (NDPCP) as a way to promote diagnosis and early intervention in diabetes (6), but has not used Twitter as part of their health education “Do Not Wait for Diabetes!” (DNWD) Campaign on this topic (7).

The goal of the project is to increase the frequency of undiagnosed patients suffering from T2D presenting for T2D screening in KSA. T2D is a severe chronic metabolic disorder (8) with a worldwide prevalence in adults of about 8.5% (9). Undiagnosed T2D is a major problem in KSA. While there are few barriers to access public healthcare in KSA (5), lack of knowledge of symptoms and the seriousness of the condition among the population is leading to underdiagnosis and diagnosis at later, more severe stages (10). The KSA healthcare system is a mixture of public and private entities; the public entities are free-of-charge and accessible to the population, and the private entities are used by those who can afford them to supplement the care they get from the public infrastructure (5).

Because Saudi Arabians of all ages are high-level users of Twitter (11,12), I proposed that a social media campaign using Twitter that promotes presenting for

diabetes screening could be successful at disseminating diabetes knowledge and improving diabetes screening rates.

Using Twitter to promote the DNWD Campaign in KSA would be considered a novel concept, as a study of United States (US) local health departments (LHDs) showed that they are only beginning to use Twitter to disseminate health information regarding diabetes (13), and using social media campaigns such as Twitter with T2D patients represents an emerging field of research (14).

1.2 Aim and Objectives

This project aims to assess the feasibility of using social media to promote T2D screening among patients at risk of developing T2D in KSA and ultimately increase the screening frequencies for undiagnosed T2D patients in KSA.

The objectives of this project are:

1. To develop a targeted social media model for the DNWD Twitter Campaign
2. To compare the frequencies of positive diabetes screening before and after the DNWD Twitter Campaign intervention (Substudy 1)
3. To measure users' engagement and satisfaction with the DNWD Twitter Campaign (Substudy 2)
4. To conduct a qualitative pilot study to explore other stakeholders' views on the sustainability of the DNWD Twitter Campaign (Substudy 3)

1.3 Summary of Literature Review and Theoretical Framework

The literature review chapter starts with a discussion of the different types of review methodologies and explains why a narrative literature review format was

selected. Next, a summary about the current state of T2D in KSA and KSA's response is presented. This section also covers public health strategies for increasing T2D screening, and what is known about the current efficacy of KSA public health strategies aimed at increasing screening rates.

The Health Belief Model (HBM) is described and applied to the problem of underdiagnosis of T2D in KSA. The HBM has been selected as the theoretical framework for this study as it is a public health framework used to design public health promotional campaigns and is “by far the most commonly used theory in health education and health promotion” (15). It conceptualizes a model under which people choose to engage in healthy behaviors, which takes into account individual perceptions, modifying factors, and the likelihood of action (15). The HBM was used as a framework to guide the development of the public health Twitter campaign.

This portion is followed by a discussion of social media in public health, and how Twitter specifically can be used to disseminate public health information in KSA, due to its popularity there, and spur the public to action.

1.4 Summary of Methodology

This section will summarize the methodology for each substudy. Substudy 1 is actually to develop the public health Twitter campaign. First, a group of subject matter experts working at the NDPCP were assembled into a committee. The group included the researcher, who would be executing the campaign, a diabetologist, a nurse, a social worker, and others. This group served as an advisory group. The researcher developed a Twitter manual to guide the campaign, and implement the policies of the campaign. The advisory group reviewed tweets before they were sent. The researcher engaged

with the users on Twitter, collected data about Twitter, and brought questions back to the committee when needed. The campaign ran from November 2017 through July 2018.

For Substudy 2, it was originally envisioned that monthly spreadsheets submitted to the MoH with aggregate data on frequencies of T2D referrals to two clinics would be easily transferable. That would have allowed monthly frequencies to be available, so the frequencies from the time period before the campaign started could be compared to frequencies achieved during the campaign. Unfortunately, the data were not formatted the way that was anticipated. Data were re-collected by the researcher from the clinics, but it was felt by the clinical staff that the data were not accurate. Therefore, it was not possible to do a robust comparison, but a descriptive analysis of the data collected is presented.

For Substudy 3, an anonymous online survey was developed aimed at followers of the NDPCP Twitter account that asked these users about their engagement and satisfaction with the tweets. The survey was conducted at the end of the campaign, and total of over 800 surveys were collected. A descriptive analysis was conducted.

For Substudy 3, 12 stakeholders from the two participating clinics were interviewed. They were asked questions about sustainability of the program, including project design, implementation factors, and factors within the organization setting and the broader community environment. At each location, three nurses, two physicians, and an NDPCP official were interviewed. A thematic analysis was conducted.

1.6 Assumptions and Limitations

This project has the following assumptions and limitations. First, although the tweets were in Arabic, targeting members of the KSA community, it was assumed that other Arabic speakers were also exposed to the DNWD Twitter Campaign. Next, a limitation in Substudy 1 was that any increase in the frequencies of screenings for T2D in KSA would be multi-causal and thus could not be directly attributed to the DNWD Twitter Campaign. If frequencies of screening were increasing before the onset of the DNWD Twitter Campaign, an assumption could be made that the increasing trend was simply continuing, and would have continued regardless of the Twitter campaign. Third, the HBM has not been widely used to guide KSA public health studies or to study social media campaigns. Therefore, although the HBM has been used extensively for other public health purposes, the HBM may not have been the optimal model to guide this campaign. In addition, even if in Substudy 2, the user survey showed that users were satisfied and engaged with the tweets from the DNWD Twitter Campaign, it would not directly mean that it influenced them, educated them, or changed their health behaviors. Finally, regardless of what Substudy 3 concludes, the MoH may choose not to implement the program permanently because of reasons other than sustainability.

2.0 Literature Review and Theoretical Framework

2.1 Literature Review

This section presents the literature review on the topic of T2D in KSA, and using social media for public health promotion. First, issues surrounding T2D in KSA are described, including a description of the KSA healthcare system and KSA's public health response. Next, public health promotion and screening strategies for T2D are discussed, specifically relating to use of social media in public health. Third, the guiding theoretical framework for this project, the HBM, is described. Finally, how Twitter can be used to promote T2D screening in KSA is described.

2.1.1 Type II Diabetes in Saudi Arabia

T2D is a severe chronic metabolic disorder that leads in co-morbidities such as cardiovascular disease, kidney disease, retinopathy and significant disability (8). According to the World Health Organization (WHO), the worldwide prevalence of T2D in adults 18 years of age has risen from 4.7% in 1980 to 8.5% in 2014 (9). In 2012, WHO estimated that 1.5 million deaths were caused by T2D, and T2D is major cause of blindness, kidney disease and failure, cardiovascular comorbidity including heart attacks, as well as stroke and lower limb amputation (9).

T2D is also a growing health concern in Saudi Arabia. According to the International Diabetes Federation (IDF), the prevalence of T2D in the Saudi Arabian adult population in 2017 was 18.5% (16). In addition to the high prevalence rate, there is evidence that there is also a high incidence rate. A 2015 study by the IDF found that the annual incidence of T2D in Saudi Arabia was 31.4 per 100,000 people (3). This issue is having a negative impact on Saudi Arabian society, as the number of deaths in 2015

due to T2D was over 20,000, and the cost per person with T2D was \$1,145.30 (about 900 British pounds) (1). A 2015 analysis of the Saudi Health Information System (SHIS) calculated the cost of diabetes to KSA in 2014 as 17 billion Riyals (about \$4.5 billion, or 3.5 billion British pounds) (17).

The SHIS is a national multi-stage survey of Saudis aged 15 years or older (10). According to a 2014 analysis of the SHIS, 1,745,532 Saudis aged 15 and older have diabetes, and that is 13.4% of the population (10). The SHIS analysis found that among those who have diabetes, 57.8% are undiagnosed, 20.2% are treated but their diabetes is uncontrolled, 16.6% have treated controlled diabetes, and 5.4% are diagnosed but untreated (10).

In 2014, the IDF used different data to estimate that there are 3,487,300 diabetes cases in KSA (1). In their report, the IDF also estimated that 1,244,300 of these cases are undiagnosed, which is 36% (1). This is a lower percentage than was found in the SHIS, where 58.7% were estimated to be undiagnosed patients with T2D. Even if the rate is between 36% and 58.7%, it should be seen as high when considering that the equivalent estimate for the United States is only 28% (18). The difference between the SHIS and the IDF rates are likely due to differences in measurement and data collection approaches (1,10), but both estimates of the percentages of undiagnosed patients with T2D in KSA are high.

2.1.2 Response to Type II Diabetes by Saudi Arabian Ministry of Health

Leaders at the KSA MoH NDPCP have developed the DNWD Campaign (7). In a phone interview, the NDPCP Director explained that KSA priorities with respect to T2D are focused on getting those who have T2D but are undiagnosed into clinical care. To

that end, the NDPCP office is promoting the health education DNWD Campaign to promote general health knowledge about diabetes, including childhood and gestational diabetes, and to encourage the KSA population to not wait until they have diabetes, but to get screened as soon as possible (7).

The NDPCP has a web page with health information, such as health education about T2D for both physicians and patients. There are many Arabic-language reports posted in an online library providing health education for patients with T2D on topics such as dietary approaches during Ramadan and Hajj, foot care, tips for traveling, and information about safety during sports. The page provides information about Type I diabetes as well. The web page also promotes T2D-related events, and provides a listing of MoH diabetes centers (19).

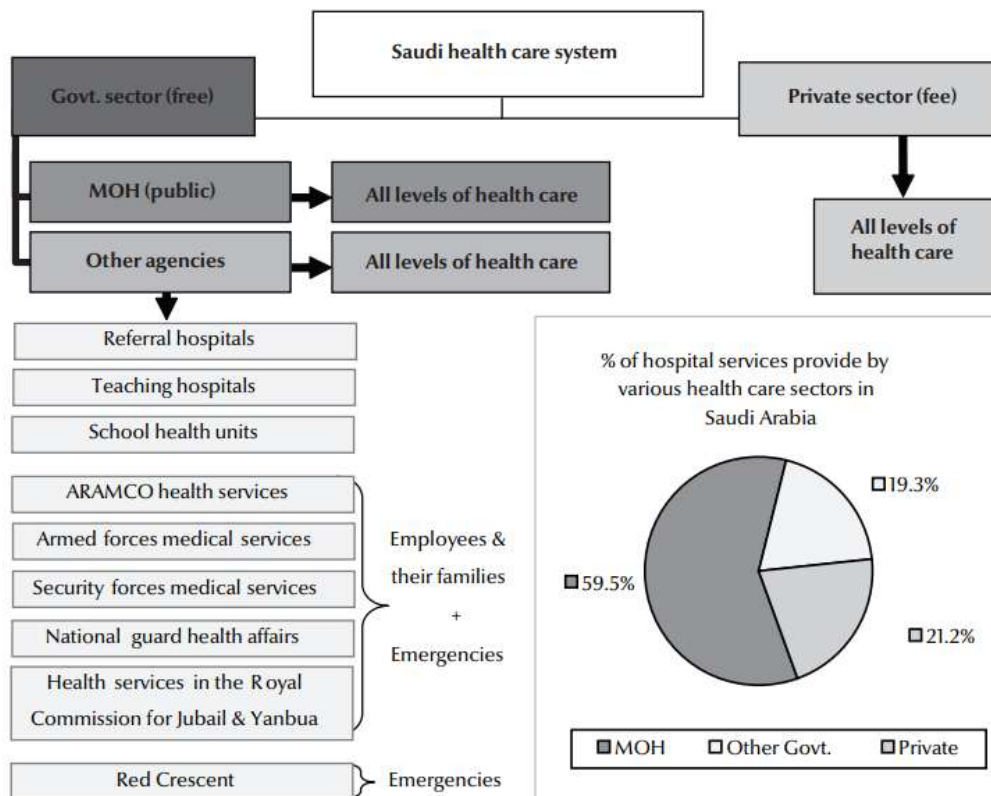
Though the NDPCP has its own web page and Twitter account, it has not used Twitter for a targeted campaign. Instead, the NDPCP Twitter account historically has promoted health messages and advertises events (20). This is similar to what is done by the Centers for Disease Control and Prevention (CDC) in the United States, which has a CDC Diabetes Twitter account (21). As of October 2016, both accounts had close to 1,500 followers, and the NDPCP was sending a handful of tweets out every few days (20). The vision was to use the NDPCP's Twitter account to launch a social media campaign aimed at encouraging Saudi Arabians to get screened to determine if they are positive for T2D and require management.

2.1.3 Overview of Saudi Arabia Health System

The KSA healthcare system is currently in flux (22). As of 2011, the WHO ranked the Saudi healthcare system 26th of 190 of the world's healthcare systems, in front of

Canada (ranked 30), Australia (ranked 32), and New Zealand (ranked 41) (5). Figure 1 shows the basic components of the KSA healthcare system, and how they are related.

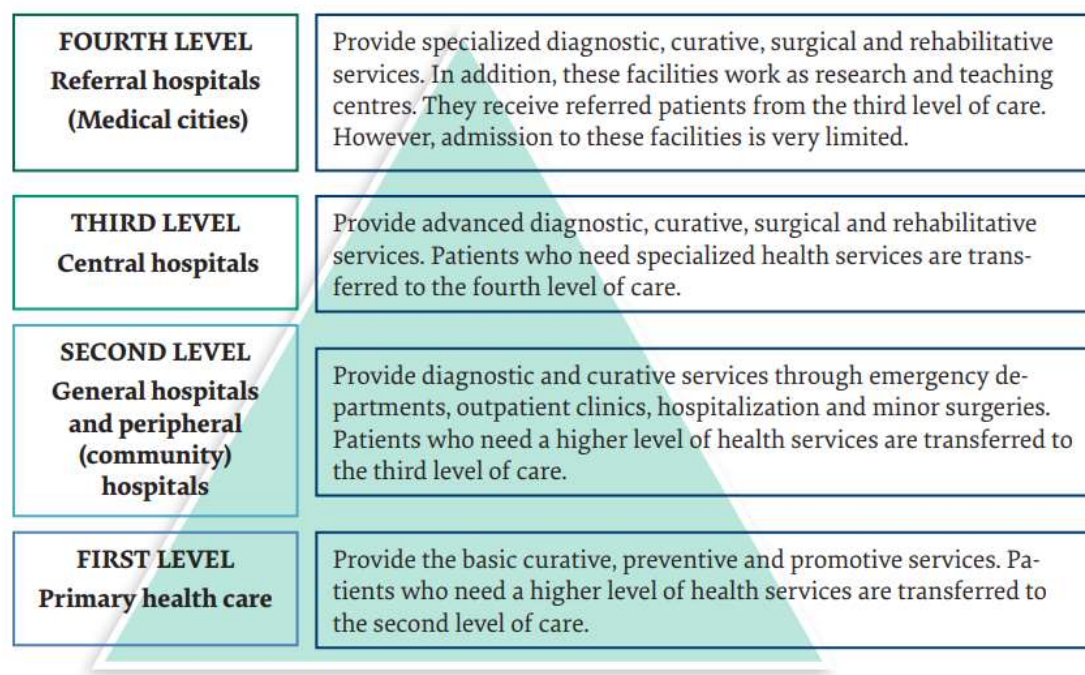
Figure 1. The Saudi Arabian Healthcare System



Reprinted from Almalki, et al. (5).

Figure 1, however, has changed in some ways as the KSA healthcare system has expanded. Since 2016, KSA has been implementing a countrywide strategy called Vision 2030, which impacts all sectors public and private (23). Under this strategy, the four levels of healthcare described in Figure 2 are being developed and expanded.

Figure 2. Levels of Care in the Saudi Arabian Healthcare System



Reprinted from Al Asmri, et al (22).

As shown in Figure 2, the first level of care is primary healthcare. This is delivered in two main settings: primary healthcare centers (PHCs) in the community, and outpatient healthcare settings at large central medical cities, such as National Guard Health Affairs (NGHA) as described on Figure 1. PHCs can be public or private, where public services are offered for free to Saudi residents. Private services are available to Saudi residents for a fee, and exist to also serve non-Saudi residents who are in KSA by way of their employers. The employers are required to ensure that private medical services are available for their non-Saudi employees.

The second level of healthcare in KSA is comprised of general and community hospitals. These hospitals include both public and private. Again, Saudi residents may use the public hospitals free of charge, and must pay a fee when using private hospitals. Non-Saudis are served by private hospitals for a fee, typically paid by their

employer. This level of care handles non-specialized needs in the community. If more specialization is needed from a hospital setting, the patient will be referred to the next level of care, which is comprised of central hospitals.

Central hospitals are present in the large medical cities in urban areas, such as King Abdulaziz Medical City (KAMC) in Riyadh. Although public hospitals include prestigious and acclaimed hospitals such as KAMC, there may be a long waiting list for Saudi residents, which may lead them to choosing private services for pay over services free-of-charge from the public sector. Therefore, there are private alternatives to central hospitals, but the public sector is very strong in this area.

Finally, the fourth level of care is comprised of referral hospitals, which are similar to specialty hospitals delivering tertiary care. An example would be the King Faisal Specialist Hospital and Research Center (KFSHRC), which is known for its highly specialized treatments in cancer, cardiovascular disease and genetics.

2.1.4 Public Health Strategies for Increasing Diabetes Screening

Public health strategies for improving T2D screening rates have generally not focused on community-based interventions that target the general population, and rather have focused on particular risk groups and strategies that can be implemented in healthcare. For example, Duran et al. did a study to determine the optimal criteria to use for screening pregnant women for gestational diabetes in clinical care (24). There is a large body of literature on this topic of identifying gestational diabetes in pregnant women through screening and provider education interventions in clinical care (25–28). Other sub-populations targeted for T2D screening programs include tuberculosis patients (29), Asian Americans (30), and patients on anti-psychotic medication (31).

Few population-based strategies for improving T2D screening rates in the general population appear in the literature. One study in the United Kingdom (UK) that compared two different T2D screening programs and a control group implemented at a total of 33 general practices found that after screening over 11,000 people, only 3% were ultimately diagnosed with T2D (32). Their analyses also indicated that screening was not associated with a reduction in all-cause, cardiovascular, or diabetes-related mortality within 10 years, and concluded, “the benefits of screening might be smaller than expected and restricted to individuals with detectable disease” (32). The main problem with this approach was that the positive predictive value (PPV) of those being screened was so low that resources were essentially wasted. The study researchers determined which group to screen based on calculation of a T2D risk score and choosing a cutpoint; perhaps the risk score they used was not as accurate in their population as they had hoped, or the cutpoint was set too low (32). In any case, their PPV would have been improved if they had somehow used an algorithm to only select those at a higher risk for testing positive.

In 2012, the Canadian Task Force on Preventive Health Care (CTFPHC) updated their recommendations on screening for T2D in adults (33). They reviewed the literature, and their recommendations include focusing on screening adults who are high or very high risk of T2D, rather than focusing on the population at large (33). To achieve filtering in a high risk group, the task force recommended using a validated risk calculator for T2D, and recommending that only those who score as high or very high be referred for screening (33). Complications with using a risk score in an effective way may have been responsible for the low PPV found in the UK screening study.

The reason why a low PPV is problematic in T2D screening is that it represents a waste of resources. Kahn et al. studied the cost-effectiveness of T2D screening, and found that “in the US population, screening for T2D is cost-effective when started between the ages of 30 years and 45 years, with screening repeated every 3–5 years” (34). However, how exactly this can apply to strategizing the optimal subpopulation to screen for T2D in KSA is unknown, because the nature of T2D risk in this population and the prevalence of risk factors at different ages are quite unique.

2.1.5 T2D Screening, Surveillance and Public Health Promotion in Saudi Arabia

Currently, Saudi Arabia has a surveillance system to monitor frequencies of positive T2D diagnosis. Data on T2D positive screening frequencies at each MoH clinic are continuously collected from all MoH clinics per MoH policies. The MoH follows diagnosed individuals longitudinally. These data are analysed by MoH monthly, but are available at any time for the purposes of this study.

Previously, a traditional public health campaign that targeted the Eastern Province and included these MoH clinics was successfully implemented in 2004, and resulted in over 200,000 people (i.e., 33% of the target population) being screened (35). However, the investigators noted that the PPV was only 16%, and suffered from a high rate of non-follow-up for clinical confirmation of a positive screening (35). The Eastern Province has been found to be a built environment that creates risk factors for T2D, such as having small houses that are poorly organized and hard to move around in, having poor ventilation, and having a neighbourhood that is difficult to walk around (36).

Currently, in the public sector, if any patient at the outpatient level of care in the public sector healthcare facilities in KSA is suspected to have T2D, they are referred to

a specialized MoH diabetes centre where they will undergo testing and follow-up. Hence, public health campaigns in KSA aimed at T2D screening essentially guide members of the population who are likely to be positive for T2D to undergo screening at one of these centres.

2.1.6 Social Media in Public Health

Social media has been used for public health interventions with mixed results. Facebook has been successfully used to recruit individuals for studies (37–41), as well as in recruiting individuals to participate in a public health intervention (42). A systematic review of the effectiveness of health behavior change interventions that use social networks (including Facebook) found “modest evidence that online social network interventions may be effective, with 9 of the 10 included studies reporting significant improvements in some aspect of health behavior or related outcomes” (43)

However, Facebook and other social networks do not have the reach in Saudi Arabia that Twitter does. Saudi Arabia is home to more than 40% of active Twitter users in the Arab region (a total of 2.4 million users) (44). The Saudi Arabian government routinely provides official information to its citizens using Twitter, and tweets are regularly the center of talk shows and other traditional media in Saudi Arabia.

Twitter is a social media microblogging service that came online in 2007 (45). It had more than 305 million users as of 2015 (46). Twitter users set up free accounts online, and “tweet” out 280-character messages, although this limit was set to 140 characters until November 2017 (45,47). Users are “followed” if other users want to read their tweets regularly, and previous tweets are also searchable, so users have access to tweets from accounts they are not following (45). If a user wants to share another user’s

tweet with the user's followers, that user can "retweet" the message (45). In this way, messages can be sent virally through the Twitter network, prompting Kwak et al. to ask the question "What is Twitter, a social network or a news media?" in their 2010 article on the topic (45), although currently, Twitter is conventionally considered social media.

Twitter has been studied in public health, but the studies that have been done do not inform the current study for various reasons. Two studies conducted on tweets available in 2009 compared estimates from Twitter chatter to reported disease levels of H1N1 or swine flu, and both found that estimates derived from Twitter mirrored the estimates found through established tracking mechanisms (48,49). It is unlikely that these findings have any bearing on this study, because tracking mechanisms for diabetes prevalence must be more sophisticated, given that diabetes is chronic rather than acute, and is more difficult to diagnose than H1N1 or swine flu.

This is somewhat similar to a study by Denecke and colleagues that looked for "relevant signals" in Twitter that they could connect to real health events, such as outbreaks identified during the European football championship (50). They found that the overall number of relevant signals generated was very small, and only 5 to 20% of signals were regarded as "relevant" by the users (50). They found that many other types of communication on Twitter (such as vaccination or education campaigns and medical terms used in other contexts) generated irrelevant signals, making this approach to finding "relevant signals" not very useful (50). Like the previous study, this did not use Twitter as a communication medium, but instead was studying it as a tracking mechanism. Again, this study does not inform the current project, which will be using

Twitter as a communication medium for disseminating information, and for engaging users.

Another group tried to use Twitter messages to better understand misunderstanding and misuse of antibiotics by the public (51). The authors searched for anti-biotic related tweets and classified them as to the type of information being discussed (51). Although the authors learned quite a bit about what people discuss on Twitter with respect to antibiotic use, the study did not reveal any clear direction for better understanding the misuse or misinformation the public has about antibiotics (51).

Using Twitter for public health monitoring really does not leverage Twitter's most useful capacity in public health, which is information dissemination and real-time engagement. This point was made by Neiger and colleagues, where they observed that, with respect to health promotion and public health in social media, "most of what is reported in the literature represents one-way messaging devoid of the attributes associated with engagement", such as these studies of public health monitoring on Twitter (52). They therefore propose that partnership and participation should be the "culminating outcomes for social media use in health promotion" (52).

2.1.7 Optimal Use of Twitter

Forming optimal tweets for disseminating diabetes information has not been studied directly. In fact, a 2012 study of local health departments in the US found that very few jurisdictions sent out any tweets at all about diabetes (13). A more recent study found an underutilization of social media by public health agencies in Spanish-speaking Latin American and Caribbean countries (53). Therefore, how to formulate effective tweets for promoting diabetes screening will need to be informed by related literature.

A recent study of an Irish cancer charity's public health campaign on Twitter speaks to this issue (54). This research team studied the effect of tweets along four different themes: informative, story, shock, and humour (54). In their analysis, shock tweets achieved the most impressions, and the second most impressions were from informative tweets (54). The most engagement was seen with humour tweets, and informative and story tweets were the most retweeted (54). Their analysis suggests that the content of the tweets can affect how broadly the public health messages in them are disseminated.

Sutton and colleagues in 2014 analysed the effectiveness of warning tweets sent during 48 hours of a disaster, the Waldo Canyon wildfire (55). They measured the effectiveness of the tweets by considering number of followers gained by the accounts tweeting, rates of retweeting, and other measures (55). They found that effective characteristics of warning message content included guidance, time, location, hazard and consequence, and source (55). They also found the effective messages style factors were clear, specific, accurate, certain, and consistent (55).

The group also developed a model to deduce the attributes of the most effective tweets. Their best-fitting model included several characteristics (55). First, the sentence styles should be in the imperative (55). Second, the tweet contained a signifier in all caps. The signifier simply categorized the tweet as a certain category, such as such as "mandatory evacuation", but shown in all capital font (55). Third, the messages contained at least one Twitter handle starting with @, contained a hashtag, and contained a URL (55). Fourth, Twitter accounts that tweeted tweets that were most effective had a large amount of friends, followers, and tweets (55).

Another useful analysis that can inform the development of effective tweets is a study done of deleted tweets (56). Researchers studied what elements of the deleted tweet might have led the person doing the tweeting to have regretted the tweet and therefore removed it (56). The following topics were the ones most associated with deleted tweets: those with negative sentiment, relationship-related tweets, those containing swear words, those with references to sex or violence, those with references to race or religion, and tweets on the subject of the job, personal health, alcohol and drugs (56). This guidance provides a list of subjects to be avoided when developing optimally effective tweets.

An important consideration when making effective tweets is increasing engagement, which can literally mean increasing the rate of retweeting the tweet. This is also a good way to disseminate information across social networks (55,57). Luo and colleagues studied how to effectively target Twitter accounts that are more likely to retweet a tweet (57). They found the following attributes of accounts that increased their likelihood to retweet a tweet: having similar interest as the tweet content, having followers with similar interest in tweet content, having retweeted the author's previous tweets, having mentioned the author in previous tweets, and having a large retweet history in general (57). In addition, Wang and colleagues developed a "whom to mention" function to increase retweeting activity by those who are mentioned in the tweet (58). This function included content-based, bonds-based, and influence-based recommendations (58). A more recent study of the United States National Cancer Institute (NCI) tweets found that including photographs in the tweet was essential to

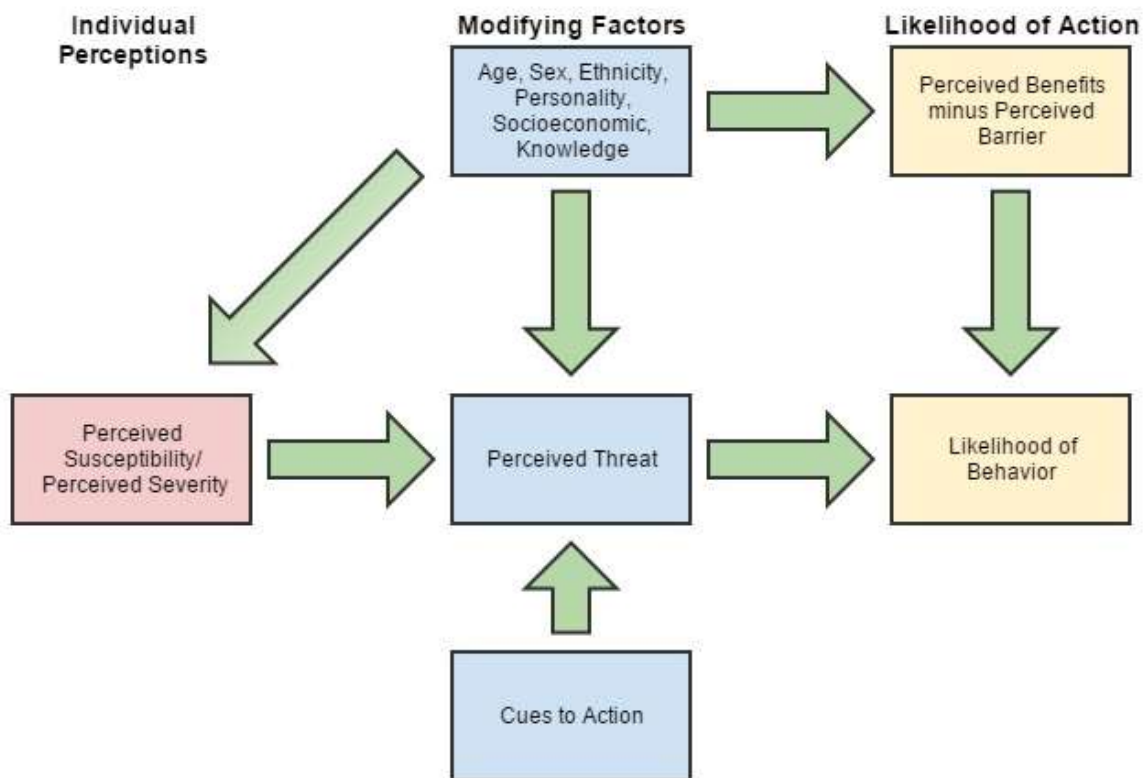
attracting engagement, and promoted engagement with social media much better than including links, videos, or status updates (59).

2.2 Theoretical Framework: The Health Belief Model

The HBM was selected as the framework to be used to guide the development of the social media public health diabetes screening promotion campaign. This is because The HBM is the most commonly used theory in health education and health promotion, and therefore, it has been shown to be effective, and much guidance on how to apply it is available (15). The HBM has been widely used as a framework for developing public health interventions for chronic disease public health promotion, including campaigns for self-care in cardiac patients (60) and weight management for obesity (61). It has been used for diabetes campaigns as well (62–64). The components of the HBM that will be included are the ones in the HBM framework, which include Individual Perceptions, Modifying Factors, and Likelihood of Action (15). This section will describe the HBM.

The components of the HBM are shown in Figure 3. The three main concepts in the HBM are Individual Perceptions, Modifying Factors, and Likelihood of Action. The components must be considered in relationship to an individual action that the public health campaign is looking to increase (such as T2D screening). The individual perceptions affect an individual's consideration of actually engaging in this action. The main two perceptions that influence this action in the HBM are the individual's perceived level of susceptibility to the public health threat, and the individual's perceived severity of the public health threat (15).

Figure 3. Components of the Health Belief Model.



Adapted from Hayden (15).

As an example of how individual perceptions of susceptibility and severity were addressed in a public health intervention on diabetics, an article by Zareban et al. can be used for illustration (65). This study used the HBM to guide a public health intervention which was an educational program aimed at patients with T2D to increase their self-care behaviors (65). The education program included components that were intended to educate the patients that they were highly susceptible to T2D-related complications if they did not engage in self-care, and that these complications could be severe, such as amputation (65).

Next, the HBM considers the role of modifying factors in individual perceptions, as well as in what spurs the individuals to action (15). Demographics such as age group

and being formerly married were associated with higher rates of underdiagnosis in the SHIS analysis; these may represent modifying factors that influence individual perceptions of susceptibility and severity in a direction away from choosing screening. In another health education study aimed at increasing walking as an exercise in T2D patients that used the HBM as a guide, researchers found that who actually delivered the educational program modified individual perceptions (66). Peer educators were better at increasing knowledge about the benefits of walking than the current educational program, so they served to be a modifying factor (66). The goal of manipulating the modifying factors in the HBM is to affect their influence on individual perceptions. If the individual can now perceive a threat, this can serve as a cue to the ultimate desired public health action.

Finally, in the HBM, the likelihood of taking the desired public health action is considered. Not all HBM-based interventions studied in T2D patients actually gather outcomes, so while it may be clear that individual perceptions were positively influenced, it is not clear if this resulted in an increase in the desired public health action. (66,67). Zareban et al., however, measured HbA1c levels, and found that their intervention must have increased the likelihood of engaging in the desired public health action, which was an increase in T2D self-care in their intervention group (65). This is because they showed that HbA1c levels were lower in the intervention vs. control group (65).

As the HBM has been successfully and scientifically applied to designing public health promotion campaigns aimed at patients with T2D, it was selected as the framework for the DNWD Twitter Campaign.

2.2.1 Applying the HBM to Promoting T2D Screening in Saudi Arabia

This section focused on applying the features of the HBM to the problem of lack of screening behavior in undiagnosed patients with T2D in Saudi Arabia. The three components of the model – individual perceptions, modifying factors, and likelihood of action - were considered here.

2.2.2 Individual Perceptions

Currently, little evidence is available in the literature about how the Saudi population perceives their susceptibility to T2D, and how they understand its severity. In a recent study of T2D patients and patients without T2D attending a primary care clinic in Makkah, 91.2% were sufficiently aware of T2D, and the most frequent sources of information on T2D were mass media (57.4%), information originating in the health sector (29.9%), and information from the educational sector (10.6%) (68). However, the sample surveyed was not very knowledgeable about secondary complications of T2D (68). In the sample, 33.7% were diagnosed with T2D, and 97.9% reported a family history of T2D (68). This suggests that Saudi Arabians are aware of their susceptibility to T2D, but may not be as aware of its severity. A different recent study focused on the Northern Border city of Arar, and conducted a similar survey of patients, both with and without T2D, attending a primary healthcare clinic (69). Similar to the other study, 10.4% of the sample was diagnosed with T2D, and the sample seemed to have a high level of knowledge about T2D, as 86.3% believed that healthy diet, exercise, and medication are part of the treatment for T2D, and 63.1% said that weight loss and lifestyle modification were the most important preventions for T2D (69). But only 24.5% reported knowing about retinopathy and loss of vision as complications, suggesting again that

Saudis may be aware of the T2D, but not the severity of its complications (69). These findings were echoed in an earlier study, where researchers used the HBM to study Saudi adolescents' perceptions of their susceptibility and understanding of the severity of T2D (70). The authors found that "an alarmingly high number of Saudi students were unaware of type 2 diabetes severity and associated risk factors" even though 63.4% had at least one family member with T2D (70).

The rest of the studies of Arabian Peninsula populations found focused on perceptions of T2D susceptibility and severity in diagnosed T2D (71) and various healthcare professionals (72,73). However, given the state of the epidemic in Saudi Arabia, it is predictable that the perception of susceptibility in the general population can be relatively high while simultaneously, the perception of severity is low. Perhaps it is this disconnect that leads Saudis who suspect they may have T2D to not feel that screening is important. They may not see the value of screening for early diagnosis to facilitate early intervention and management because they do not fully appreciate the severe complications that can arise without management.

2.2.3 Modifying Factors

As with perceptions, modifying factors that affect the Saudi person's thinking when considering obtaining a T2D screening are not known. Unlike the US, Saudi Arabia has a public healthcare system, so it is likely that income and access to care do not play a major role and are not important modifying factors. Most Saudis are ethnically Saudi (74), so ethnicity is likely not a modifying factor, either.

From the analysis of the SHIS article, it appears that sex does not play a role, but age may. Those in age groups over 45 are at risk, but do not appear to be modifying

their behavior. Also, unmarried people apparently were higher risk for lack of diagnosis, so marriage may be a modifying factor. In fact, one of the studies described earlier found that marital status was associated with T2D awareness (68).

Given the current state of the literature, Saudis do not generally perceive a threat from T2D, even though it is a common problem and Saudis can see their family members suffering. This suggests that the lack cues to action. For example, it appears that when one family member is diagnosed, the other family members do not make an effort to get screened, because they do not perceive this as a threat to themselves, and they do not perceive a cue to action. Currently, it is unknown what modifying factors could be manipulated to increase the Saudi's threat perception from T2D.

2.2.4 Likelihood of Action

The likelihood of action can be reduced to the equation of "perceived benefits" minus "perceived barriers" equals "likelihood of behavior". Currently, it is not clear whether Saudis see low or no perceived benefits from T2D screening, high barriers to screening, or both. In any case, the equation currently adds up to a low likelihood of Saudis being screened.

2.2.5 Using the HBM to Guide T2D Screening Campaign Development for Saudi Arabians

To reflect on applying the HBM as a guide to developing a T2D screening campaign for Saudi Arabians, an important point that has been revealed in the literature is that Saudis have a low threat perception of T2D (70), and it is not clear what factors modify this perception. The challenge of any T2D screening campaign aimed at Saudi Arabians currently is to increase this threat perception. Also, focus would need to be

placed on emphasizing the perceived benefits of screening, and downplaying the perceived barriers. In fact, a strategy for educating the public on how to get through the barriers may increase screening. Simply providing information about what actually happens in a clinical screening, and what happens in clinical care for T2D may serve as a modifying factor. Having more high-quality information about T2D may promote the identification of cues to action that would increase the likelihood of going for screening.

2.3 Using Twitter to Promote Diabetes Screening in Saudi Arabia

Social media, including Twitter, has been reshaping healthcare and the practice of public health (75). Although the NDPCP has its own web page and Twitter account, the DNWD Campaign specifically was not planned to have any social media or internet presence. The NDPCP Twitter account existed and promoted health messages, but it was decided that during the DNWD Campaign, the NDPCP Twitter account would be used specifically for DNWD messages (20). Prior to the DNWD Twitter Campaign, the NDPCP regularly sent tweets to its followers regarding T2D health information. This is similar to the approach taken by the Centre for Disease Control and Prevention (CDC) in the United States, which has a CDC Diabetes Twitter account (21). When the DNWD Twitter Campaign was initially designed, both the NDPCP and CDC Diabetes Twitter accounts had close to 1,500 followers, and the NDPCP was sending out a handful of tweets out every few days (20). The tweets on the NDPCP account were mostly a mixture of diabetes information and job/volunteer announcements.

Before the DNWD Campaign, the NDPCP was not using its Twitter account specifically to recruit Saudis with undiagnosed T2D to undergo screening, which may represent a missed opportunity to reduce the number of undiagnosed T2D patients in

Saudi Arabia. This prediction is in line with a recent study in the US, that found that local health departments (LHDs) were underutilizing Twitter in their health promotion campaigns (13), as well as the study of Spanish-speaking Latin American and Caribbean countries that found an underutilization of public health governmental agencies of social media (53). The Community Preventive Services Task Force therefore put out a guide to health communications campaigns using social media to guide those who are setting up social marketing campaigns in this new environment of social media (76). Even though this was a result of a systematic review, because social media are so new, there could be no evidence-based recommendations specifically about social media (76).

One 2013 study looked at the Twitter accounts for LHD's in the US that had posted a minimum of 50 tweets (77). Even though the authors identified a total of 2,565 LHDs, only 210 (8%) qualified by having a Twitter account and posting at least 50 tweets, echoing the fact that LHDs are underutilizing Twitter (13,77). Among the study's main findings were that approximately 40% of tweets sent from these accounts were about the organization, and 60% were about personal health (77). The authors also found that only 35% of organizational tweets tried to engage followers in conversation, and only about 40% of personal health tweets encouraged action (77). A different study looking at tweets from American Heart Association, American Cancer Society, and American Diabetes Association found that the majority of tweets were about organizational topics, and fewer about personal health (78). They also found that the organizations had differing amount of engagement, as measured by the use of the retweet and reply functions in Twitter (78). More tweets that encourage conversation or

action would likely improve engagement as well as beneficial health activities among those reading the tweet.

Social media has been underutilized in public health, so selecting the optimal social media platform for a public health campaign is hampered by a lack of an evidence base. Facebook has been successfully used to recruit individuals for studies (37–42), but Facebook does not have the reach in Saudi Arabia that Twitter does. Saudi Arabia is home to more than 40% of active Twitter users in the Arab region (a total of 2.4 million users) (44). The Saudi Arabian government routinely provides official information to its subjects using Twitter, and tweets are regularly the center of talk shows and other traditional media in Saudi Arabia. This suggests that even though Facebook has been studied in public health, Twitter would be a more appropriate social media to use for a public health campaign in Saudi Arabia.

A different approach to reaching this population using Twitter may be more successful at targeting high risk individuals to encourage them to visit a primary care clinic for screening, making follow-up more likely. It is also estimated that the PPV of Twitter-referred patients will be higher than 16% through content-targeting of those who are suspected of having high levels of risk factors. Twitter offers analytics which have demonstrated that tweets reflect health trends in the population (79). Currently, Twitter has been used in public health for syndromic surveillance (79) more than as a communication and information intervention (13), but Facebook has successfully been used for this (37,42,75). One recent using Twitter for public health messaging had encouraging results (54). Therefore, it is reasonable to suggest that a well-constructed

public health information campaign on social media could influence population parameters (76).

Using Twitter to promote the DNWD Campaign in Saudi Arabia would be considered a novel concept, as a study of local health departments showed that they are only beginning to use Twitter to disseminate health information regarding diabetes (13), and using social media campaigns such as Twitter with diabetics represents an emerging field of research (14,54,78).

3.0 Methods

3.1 Overview

This section begins with presenting information about the execution of the DNWD Twitter Campaign, and about the overall research design for this project. In order to accomplish the objectives of this project, three (3) substudies were completed, and these were described separately.

3.2 The DNWD Twitter Public Health Campaign

3.2.1 Establishing the Campaign Strategy

The first objective of the study was to develop a targeted social media model for the DNWD Twitter Campaign. To achieve this, the author offered to conduct a Twitter information campaign designed to promote the health information included in the DNWD Campaign. The Director of the NDPCP agreed to partner and also make her team available for consultation. These preliminary discussions revealed that the NDPCP had one main Twitter account (20). The NDPCP account was being underutilized for health promotion; this is in line with research that suggests local public health departments in general are underutilizing social media for health promotion (80). Therefore, it was decided that during the DNWD Twitter Campaign, the researcher would have direct access to the Twitter account and would not only be responsible for sending official tweets, but also for interactions on Twitter, including retweeting and liking tweets.

This decision prompted the necessity for a formal process for approving tweets. A Twitter manual for the DNWD was developed to formalize the process of designing and approving tweets (see Appendix B). In 2017, World Diabetes Day fell on November 14, and the entire month of November is considered diabetes month in Saudi Arabia

(81,82). The NDPCP therefore launched the DNWD Campaign on November 14, 2017, and that is also when the author launched the DNWD Twitter Campaign.

3.2.2 Account Management

At the beginning of the campaign, it was decided the campaign would “take over” the official NDPCP Twitter account, which is @NDPCP_MOH, instead of having a specific Twitter account just for the campaign (the way the US CDC sometimes does) (20,21). It was also agreed that this account would be taken over by the researcher for the period of the campaign, and he would log in and send the tweets on behalf of the NDPCP. It was decided that this change would take place on November 15, 2017, November is World Diabetes Month, and the DNWD Campaign in general and the NDPCP specifically was promoting health information about diabetes. The DNWD Twitter Campaign was envisioned as part of this portfolio of health messaging.

On November 1, 2017, the NDPCP Twitter account had 5,941 followers, and had sent under 3,000 tweets. These tweets were sent either by the NDPCP Director or her assistant at her direction, and mainly promoted events and campaigns coming out of the NDPCP. With the onset of the DNWD Twitter Campaign, the account would now be tweeting more regularly. The researcher would adopt a role as a member of the Twitter community aimed at promoting health education, and would interact with other accounts to promote this role. This would essentially be an online simulation of traditional public health methods, where members of the public health field go out into the community in public places and educate the wider community.

As with traditional public health campaigns, social media public health campaigns must be managed with some internal infrastructure to ensure success. The information

being delivered to the public must be accurate, and the message coming from the campaign team should be consistent and without contradictions. It is also important to maintain the reputation and “brand” of the public health agency through this public contact.

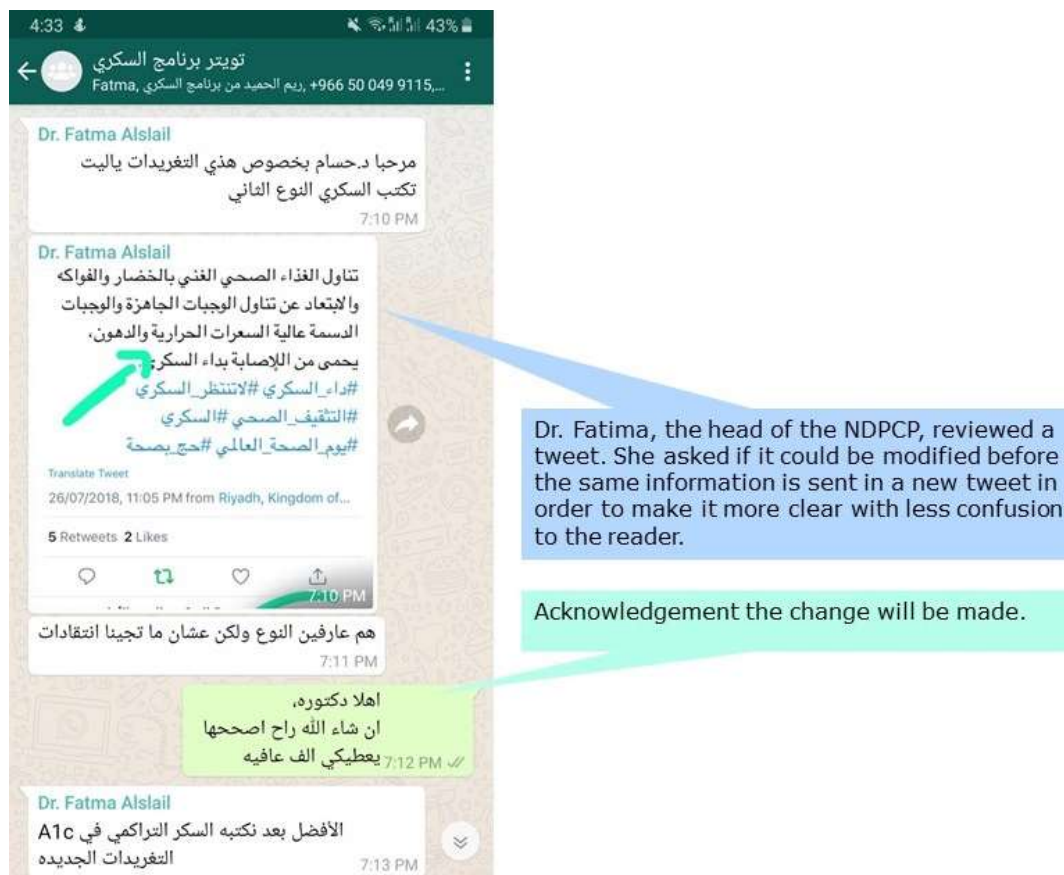
Traditionally, these management tasks were accomplished through the development of trainings, manuals, workflows, and policies. Hence, these approaches were used in the DNWD Twitter Campaign. Initially, the researcher met with the NDPCP Director and asked about how the campaign would be managed in terms of the above issues. In response, the NDPCP Director assembled a support team for the campaign consisting of herself, the researcher, a diabetologist, a social worker, a dietitian, a social behavior therapist, and a clerical assistant with expertise in English and Arabic translation. This team formed a WhatsApp group so that communication could be facilitated easily.

Next, the researcher discussed policies for tweeting with the NDPCP Director, and then documented these policies in a Twitter manual (see Appendix B). As an overview, these policies include instructions on developing tweets that meet NDPCP criteria, going through a tweet approval process, and guidance for engagement. Importantly, if a public health agency sends out messages on Twitter and ignites interaction among the users, this essentially forces the agency to improvise in conversations. This situation put the researcher in the circumstance of needing to deliver (and often correct) health information on Twitter directly to users.

In order to facilitate this ad hoc process, when Twitter users would ask for health information where there were not obvious guidelines to point to for an answer, the

researcher could use the WhatsApp group to immediately discuss the issue and receive an approved response. Figure 4 shows an annotated example of one of these WhatsApp conversations.

Figure 4. WhatsApp Conversation Regarding Tweets in the DNWD Twitter Campaign



As shown in Figure 4, the NDPCP Director had received a tweet to review before it was sent, and was giving feedback using the WhatsApp group. This was an efficient way for this group to maintain communication during the campaign even if they were not in the same location. It also allowed for NDPCP Director to maintain control over the messaging of the entire DNWD Campaign. As new policies and procedures were developed, the Twitter manual was updated, and this could then be followed by the

researcher. After the researcher's project was completed, the manual could be passed on so that if the NDPCP wanted to continue the campaign, they could train a new individual to run the Twitter account, and guide them to follow the policies and procedures in the manual.

3.2.3 Early Twitter Campaign Experience

In Twitter nomenclature, the word "impression" refers to whenever a tweet is shown to an account (83). Hence, the ultimate goal in the Twitter component of DNWD was to increase impressions of the tweets, because this would theoretically increase the likelihood individuals would change their health behavior on the basis of what is said in the tweet.

Impressions can be increased by the consideration of several attributes. First, tweets themselves must be attractive, clear, and easily found using hashtags. Next, impressions can be increased if the NDPCP account were to gain more followers. Another strategy is retweeting a tweet from another account. Also, if tweets from the NDPCP account are retweeted, they can gain more exposure fast. Furthermore, impressions can be increased by mentioning another Twitter account. In addition, if the NDPCP account itself happens to be mentioned in another account's tweet, it can increase impressions.

Other features in Twitter can drive impressions. Accounts can get in public conversations on Twitter by going back and forth with tweets, and probably the least active engagement on Twitter is to "like" a tweet. Tweets with higher numbers of likes are seen as more attractive to users, and can garner more impressions. Further, liking

tweets from other accounts can encourage those accounts to check out the Twitter feed of the NDPCP account, and maybe even follow it or retweet its tweets.

The success of strategies using these different features in Twitter can be gauged by using the Twitter analytics interface, which provides data on impressions, likes, retweets, and other metrics described above (83). Checking Twitter analytics regularly to assess the success of the public health campaign can guide the campaign leaders to shift strategies in order to reach their objective, depending on what it is.

3.2.4 Selection/Development of Tweets

The development of high-quality tweets requires several considerations. First, there are considerations associated with the text in the tweets. In this project, the text needed to be understandable by the audience, but must also contain accurate health information. Next, there are considerations associated with the images attached to the tweets. These images could simply complement the text, or they could provide knowledge on their own, such as a graph. The images also would need to be clear and understandable, as well as accurate and attractive.

Because the researcher is also a physician who has treated patients in an outpatient internal medicine and pediatrics setting, he was aware of clinical T2D knowledge and health education given in the clinical setting. For this reason, developing text for the tweets was not particularly challenging. However, the researcher did not have a background in graphic design. Therefore, a challenge the researcher faced was developing images for the tweets that were both clear and accurate, as well as attractive. When the NDPCP reviewed initial images developed by the researcher, they

were not considered optimal for the content. As a result, the NDPCP team was consulted. This discussion established two main strategies for using images.

First, the NDPCP had already developed a library of high-quality images on the topics of health promotion that are the NDPCP's priority. These images included infographics with statistics, as well as health instructions and health information. This library of images was being used with the content of the tweets. Next, the researcher himself developed images that could be used with the tweets after learning how to improve these images. These images essentially reiterated the information from the tweet text content, using pictures as well as words.

3.2.5 Following Twitter Accounts

Because the researcher was using the NDPCP's official account, he was asked not to follow any accounts not already followed. While this is understandable, it eliminates the ability to use following as a tool to expand exposure to the tweets (57,58). At the time of the study, the NDPCP account was following 71 accounts. These were mainly accounts from other health-related governmental agencies, both within and outside Saudi Arabia (20). The advantage of this is that the tweets produced by these agencies were developed with medical expertise so were safe to retweet, in that they were providing trusted official information.

3.2.6 Retweeting and Mentions on Twitter

The policies associated with the NDPCP Twitter account prevented the researcher from following new accounts without approval. In addition, NDPCP policies prevented the researcher from retweeting tweets from accounts that were not already followed. However, it was perfectly acceptable to retweet tweets in the NDPCP feed that

come from the accounts it is following. Reviews of past months of tweets on the NDPCP account found that there was an abundance of retweets. In the new strategy, retweets were interwoven with original tweets to improve interest from followers.

Another strategy to increase impressions is mentioning other accounts. At the time of the study, this strategy was not being used widely by the NDPCP for promoting exposure to tweets. The only situation in which mentions were used was when the NDPCP was promoting a joint event involving other organizations. In this case, tweets by the NDPCP account about the event only mentioned the accounts other organizations involved, but not accounts of unaffiliated organizations who may have taken an interest in the event.

On the other hand, other accounts mentioned the NDPCP Twitter account under a few circumstances. First, it was common to see these mentions in tweets about diabetes where the tweeting account's objective was to make the NDPCP aware of an event or item being promoted in the tweet. For example, the account belonging to a diabetes charity called Patient's Friends tweeted a picture and said that it was important to have healthy eating information for the diabetic. This tweet mentioned the NDPCP account in it, along with other diabetes-information-related accounts, like the Saudi Society for Diabetes and another diabetes charity.

3.2.7 Conversations on Twitter

The researcher noticed that some accounts initiated a conversation with the NDPCP account as a result of what was being tweeted. For example, one tweet about gestational diabetes explained that experiencing symptoms during exercise while pregnant can be a sign that gestational diabetes needs to be diagnosed. A Twitter

account presumably owned by a pregnant woman responded asking about what exact symptoms for which to look (see Figure 5).

Figure 5. Twitter Conversation



For replies to these conversations, the author developed a draft tweet as an answer, then ran it by the NDPCP team. The team worked to edit the tweet, and then it was sent from the NDPCP account as a response. In this case, the response said that the symptoms may be stomach ache, dizziness, and coldness in extremities.

3.2.8 Analyzing Twitter Activity Using Twitter Analytics

Because the researcher was able to access the NDPCP Twitter account, he was also authorized to download tweet metadata from Twitter Analytics, an online interface managed by Twitter that provides users access to their tweets as data (84). The author was granted access to the NDPCP Twitter account in November 2017, so was able to download tweet data from the NDPCP account as far back as July 2017. These were

stored as monthly files. These downloads are separated by month, and are formatted as comma separated values (CSV) so they can be imported into any data program.

It became clear that the information about the past tweets included both static and dynamic information. Static information about each tweet includes a unique identification number for the tweet, a permanent URL link for the tweet, and the textual content of the tweet. However, most of the information stored about the tweet is dynamic. Number of “impressions” refers to how many “times a user is served a tweet in timeline or search results” (83). Number of “engagements” refers to the total number of times a user interacted with the tweet; interactions include clicks anywhere on the tweet, including retweets, replies, follows, and likes, as well as clicking on a link in the tweet, using embedded media in the tweet, interacting with the account profile that sent the tweet, or expansion of the tweet (83). Each specific type of engagement is also tracked individually.

Typically, most of the impressions and engagements with tweets happen within days after they are posted. However, it is possible to search for old tweets in many ways, including regular internet search engines. In the case that old tweets receive new engagements, the data already downloaded about the tweet from Twitter Analytics will not include the new information. However, since most of the engagement will have taken place in the first week after the tweet was sent, this data loss is considered negligible.

An important point must be made about counting retweets and Twitter Analytics. The number of retweets received by a tweet are stored with the tweet record, so any tweet originally sent from the NDPCP account can be assessed for the number of

retweets it garners. However, when an account retweets a tweet from another account, this is not recorded in the retweeting account. In other words, when the NDPCP account retweets a tweet from another account, a record of this is not included in the Twitter Analytics data download. Therefore, to count the number of retweets sent from the NDPCP account, a manual count was done by observing the NDPCP Twitter feed. Unlike with Twitter Analytics, the tweets in a profile's Twitter feed go back to October 2013 (83).

3.2.9. Promoting Screening

Although the DNWD Twitter account was promoting all the messaging of the DNWD Twitter Campaign, given the HBM orientation of the campaign, the ultimate goal was to increase the frequency of Saudis who do not know their T2D status undergoing a T2D screening at an MoH diabetes center. Therefore, at least some of the tweets were aimed directly at broadcasting a cue-to-action about this goal. Figure 6 is an example of such a tweet.

Figure 6. Tweet Promoting Type 2 Diabetes Screening

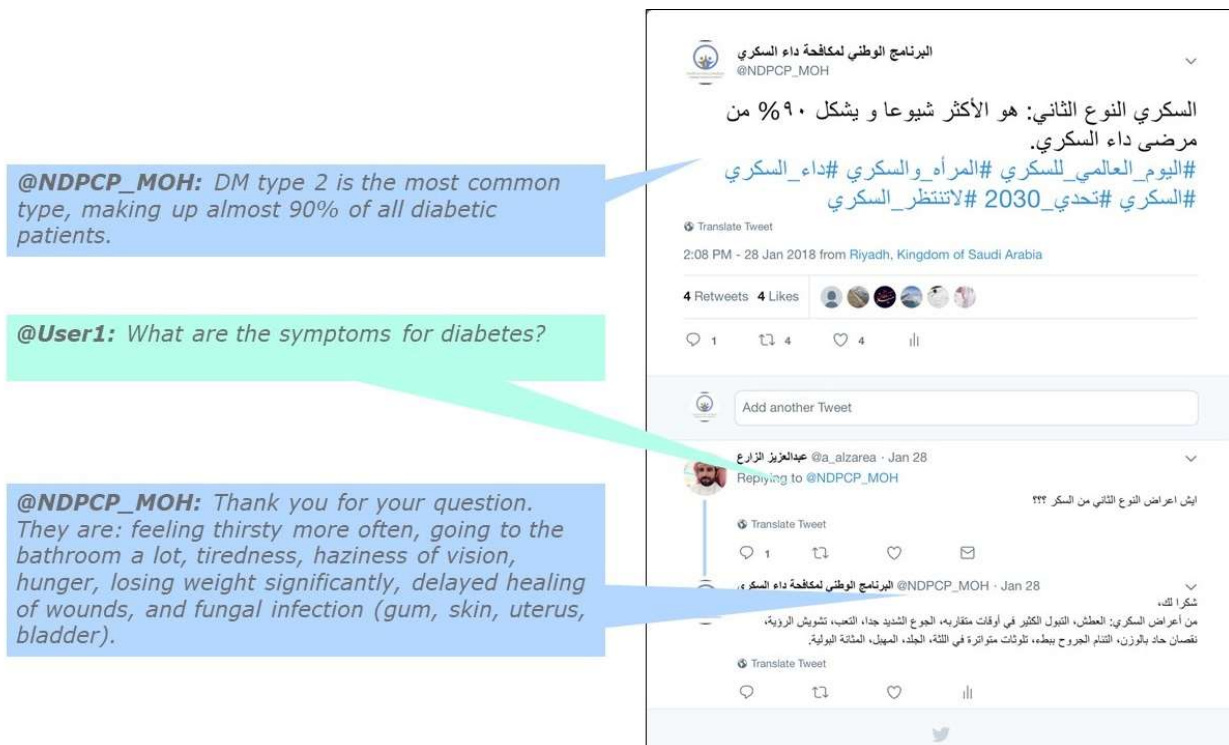


Note that in Figure 6, a user engages with the NDPCP Twitter account asking for information. At the MoH, a new central information switchboard number has been established as 937. This is being promoted throughout the MoH as the place to call to be guided through the extensive MoH healthcare setting and facilities, and to facilitate seamless healthcare delivery through this infrastructure. As this is part of the overall messaging plan for MoH, the researcher was aware of this, and therefore could respond to the tweet with this information consistent with established messaging. It also was a positive sign to the researcher that users were engaging with tweets about screening, and seemed interested in undergoing screening.

3.2.10 Public Health Activities and Interactions on Twitter

As anticipated, Twitter accounts began interacting with the NDPCP account about health information. The nature of the interactions indicated that the NDPCP was seen as a source of trusted information (see Figure 7).

Figure 7. Twitter Conversation about Symptoms of Type 2 Diabetes



As seen in Figure 7, the user asks what the symptoms of diabetes are, and the researcher was required to then provide an approved response. In Figure 8, another person asks about hypoglycemia.

Figure 8. Twitter Conversation about Hypoglycemia



It became clear that the KSA public relied on the NDPCP for truthful and accurate information, and that the NDPCP needed to maintain its trustworthy reputation by delivering accurate information efficiently. This is why it is important when running a social media public health campaign to have a well-managed set of policies and procedures to ensure that health information is delivered accurately to the public.

3.2.11 NDPCP Account as a Member of the Twitter Community

As the researcher continued to tweet regularly, the NDPCP account received more followers, and more accounts starting interacting with it. That is because regular users of Twitter became accustomed to regular tweets from the NDPCP account; thus, the account formed an audience. As a result, more complicated and involved conversations emerged (see Figures 9 and 10).

Figure 9. Twitter Conversation about Type 1 Diabetes

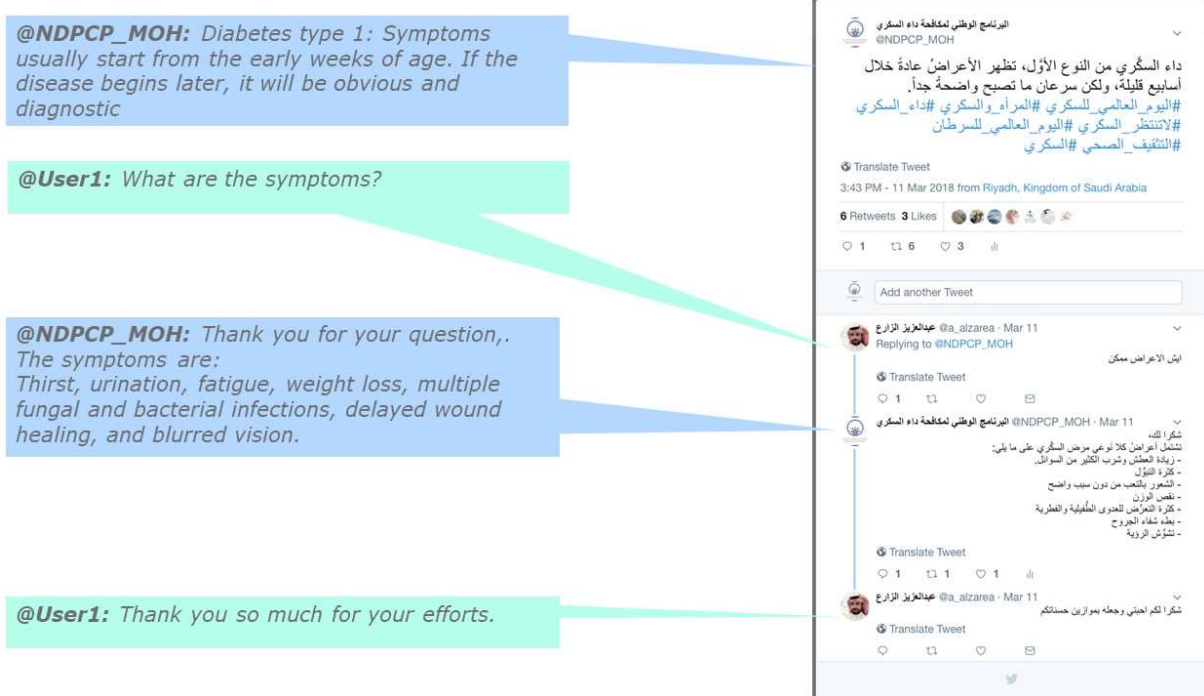
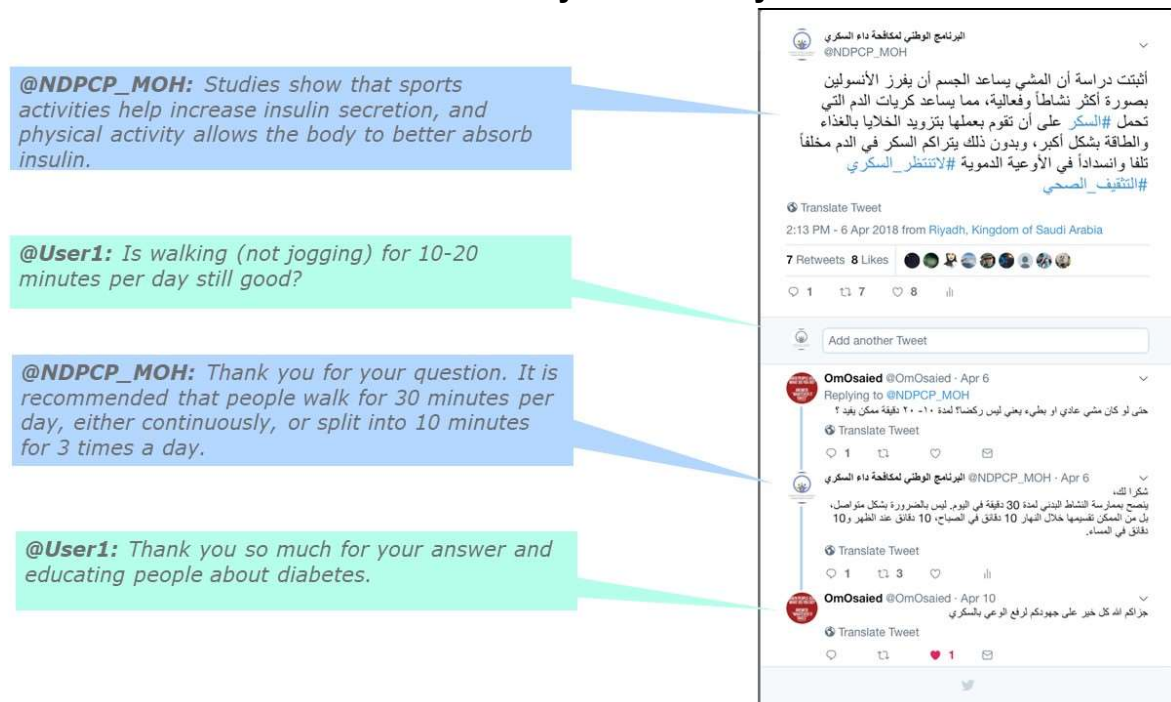


Figure 10. Twitter Conversation About Physical Activity



In Figure 9, a user has a direct interaction with the NDPCP account asking about symptoms of type 1 diabetes (T1D). The user thanks the NDPCP account for the information. In Figure 10, again, a user asked for customized public health advice about exercise, and thanks the NDPCP account for providing it. Clearly, the DNWD Twitter Campaign succeeded in establishing the NDPCP Twitter account as a contributing and valued member of the Twitter user community.

3.2.12 NDPCP Account's Public Health Role on Twitter

As the campaign continued and the reputation of the NDPCP Twitter account grew as a trustworthy and authoritative source on diabetes-related health information, users started to involve the NDPCP Twitter account in different ways in their conversations. In Figure 11, one tweet from the NDPCP account spawns a conversation between users, with the NDPCP weighing in at the end.

Figure 11. Twitter Conversation Involving Multiple Users



شكرا لك،
يجب الاستعداد من مريض السكري قبل ممارسة الرياضة، و
علي مريض السكري فحص مستوي السكر قبل و بعد ممارسة

This reputation led to an interesting phenomenon, where users would have independent conversations about T2D, and then mention the NDPCP Twitter account in hopes it would weigh in on the conversation, or in a way, supervise the conversation.

Figure 12 presents one example of this.

Figure 12. Twitter Conversation Between Users that Mentions the NDPCP Twitter Account



In Figure 12, users are debating the amount of exercise that should be done per week. In the last tweet in the conversation, the NDPCP Twitter account is mentioned, likely to encourage it to weigh in on the debate. The NDPCP Twitter account was mentioned in the context of other tweets as well (see Figures 13 and 14).

Figure 13. Tweet About Football Player Mentions NDPCP Twitter Account



Figure 14. Tweet About Reporter Player Mentions NDPCP Twitter Account



As shown in Figures 13 and 14, the NDPCP account is mentioned in an encouraging tweet about T1D. When the NDPCP account is mentioned in a tweet, all of the followers of the NDPCP account see this tweet in their feed, and the NDPCP account holder is also alerted to the mention through Twitter. The reason why having these mentions is so helpful to the campaign is that people who are following the NDPCP can then be connected to others through the mention of the tweet, and the NDPCP account holder can better understand their audience. But expanding the reach of the tweet is not the only reason users would mention the NDPCP account in their tweets. In Figure 14, users discuss how a Saudi reporter should not be promoting a sugary drink, and imply that the NDPCP should get involved.

The researcher found that it was extremely helpful to have the support team, because as he continued to manage the Twitter account and the campaign, he received more and more challenging questions. Figure 15 shows a question from a user about using a specific sweetener; Figure 16 shows a user asking about both Type I and T2D prevention, and Figure 17 shows a user asking a challenging clinical question.

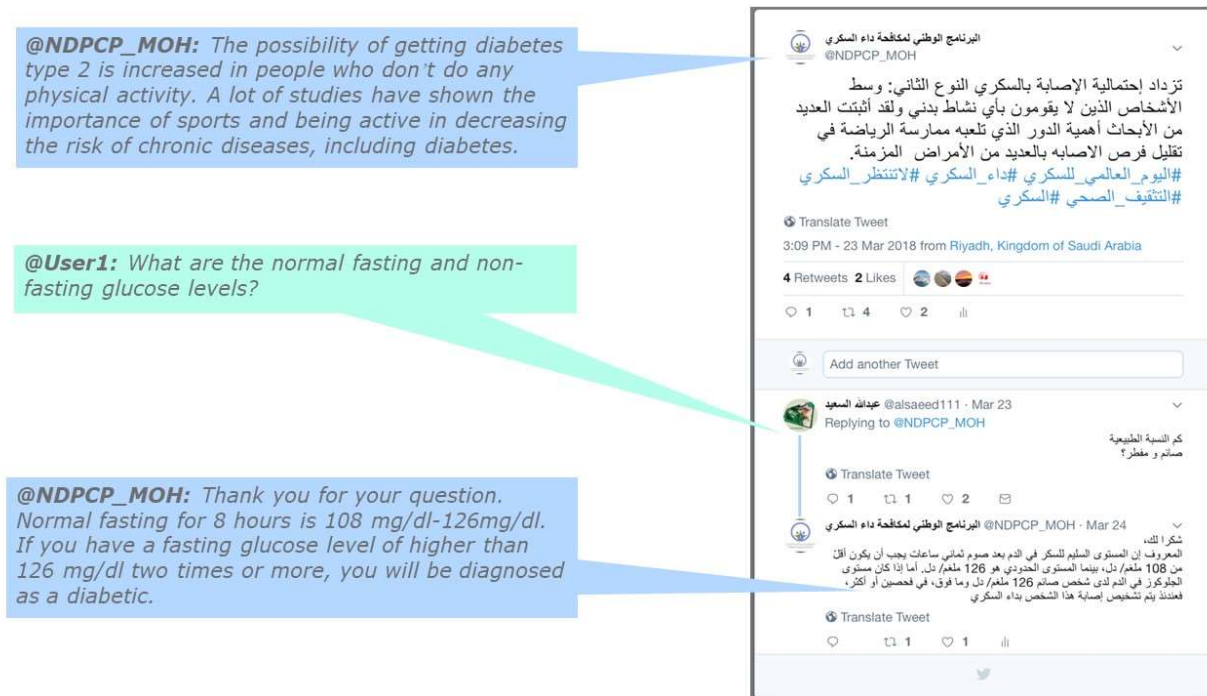
Figure 15. Challenging User Question about Sweetener



Figure 16. Challenging User Question about Prevention



Figure 17. Challenging Clinical Question from User



It was really important to have the support team available on the WhatsApp group, because then entire discussions about the correct answer to tweet back could take place. This ensured that the information being disseminated from the NDPCP was consistent and correct.

3.2.13 Negative and Mixed Reactions to DNWD Tweets

The researcher was being guided by the HBM in the formation of tweet language, and therefore, included language to increase perceived susceptibility/severity of threat of T2D, increase likelihood of T2D screening behavior, and provide cues to asking about the perceived threat of T2D (15). However, some of the language chosen induced both mixed and negative reactions. Figures 18 and 19 provide examples of this.

Figure 18. Warning from User about Risk Communication Language



@NDPCP_MOH: If a woman has gestational diabetes, the infant is at high risk for the complications of are obesity, hypoglycemia, jaundice, RDS, diabetes type II when they are older, and death.

@User1: Why are you using such language? Your role here is to warn people about ignoring their diabetes if they have it.

Figure 19. Many Negative Reactions to Tweet About Risk Factors



@NDPCP_MOH: Diabetes is a main cause of blindness, kidney failure, heart attacks, brain death, and amputation. Go to the nearest primary healthcare center for a diabetes screening test.

"I'm pregnant and have gestational diabetes. Please do not say these horrible things or I will worry. Please think about this next time."

"Thank you for scaring me off!"

"Don't worry about the tweet - I've had diabetes 17 years, and it's fine. Just don't eat junk food."

"I just got this disease, and now I'm having a heart attack after this tweet!"

"These things only happen if you do not follow doctor's orders and take your medication."

"You need to tell us how to prevent these problems."



Although it was necessary to provide information about risk factors for T2D to encourage screening, some of the language used caused negative reactions. Figure 18 shows a user reacting negatively to very direct risk communication language, and Figure 19 shows many different reactions from users to a message warning about risk factors of T2D and encouraging screening. As can be seen in Figure 19, users reacted in different ways; some comforted each other, and some admonished the NDPCP Twitter account for using such language.

It is important to understand the language and words that will best impact the audience intended on Twitter. A social media public health campaign will need to experiment with language to find out what the boundaries are, and learn what messages are received more positively.

3.2.14 Experiments with Geographic Targeting

As described for Substudy 1, although the DNWD Twitter Campaign is technically directed at all of Saudi Arabia, the data gathered for Substudy 1 focused on two T2D clinics, the ones in Al Ahsa and Hafr Albatin. These are in Eastern Province, and so the researcher experimented with increasing followers from that region.

Through these geotargeting experiments, the researcher found that he could increase followers from a certain area of Saudi Arabia by promoting events in those locations, and by retweeting tweets from locally-branded organizations, such as city government organizations and local schools. Figure 20 gives an example of a tweet that targeted the Madinah area of Saudi Arabia.

Figure 20. Example of Geotargeting Madinah Residents



**Geographic
targeting
of Madinah
residents**

As shown in Figure 20, by promoting an event associated with the DNWD Campaign that was taking place in Madinah, the researcher was able to gain more followers from the Madinah area (which was seen through Twitter analytics which can provide aggregate numbers of original locations of followers).

3.2.15 Maintaining Account Relationships

As the researcher continued to manage the NDPCP Twitter account and the DNWD Twitter Campaign, he found that there were certain reputable user accounts that were especially active in the NDPCP's feed in a very positive way. Although the NDPCP account could not follow these accounts, instead, the researcher sent direct messages (DMs) to active reputable users to encourage them to continue their engagement (see Figure 21).

Figure 21. Using Direct Messaging to Encourage Actively Engaged Users



DMs are private messages that can only be seen by the user receiving the DM.

This method can be used to cultivate an online community, even when not being able to follow accounts using Twitter's following functions.

3.2.16 Change in Followers

As was shown in the literature review, to increase a tweet's reach, it is best to attract followers, because they can help disseminate the message through retweets. An excellent method to attract followers is relatively manual, and involves tweeting high-quality tweets regularly, and engaging with users online. As the research continuously completed these tasks, he was able to see an increase in followers of the NDPCP account over the time of the campaign (see Figure 22).

Figure 22. Change in Followers Over the Campaign



As seen in Figure 22, just before the Twitter campaign started on November 1, 2017, the NDPCP account had about 6,000 followers. This grew to over 8,000 after 7 months of tweeting, and after 5 more months when the Twitter campaign was no longer running, ever more followers joined, increasing followership to almost 9,000. Simply having high-quality tweets waiting to be found with hashtags can encourage followers to follow, even if tweeting is not occurring at high volumes.

3.2.17. User Survey Participation

This researcher will report in the section on Substudy 2 the results of the user survey conducted on Twitter. However, it is important to note that survey administration on Twitter can be satisfying to both the account doing the survey, and the users taking the survey. To encourage survey participation, tweets were developed with a link to the survey, and a tweet with this link was “pinned” to the account, so it was the first tweet

seen if a user went to the NDP CP's Twitter account page. The researcher found that users enjoyed replying that they had completed the survey (see Figure 23).

Figure 23. Tweets of Confirmation of Survey Participation



For this project, using Twitter to obtain user surveys was highly successful. The user base following the NDP CP account responded enthusiastically to an invitation to complete the survey, and as shown in Figure 23, were also proud to share when they took the survey.

3.3 Research Overview

Both quantitative and qualitative approaches were used to evaluate the impact of the Twitter tweet campaign in Saudi Arabia. The purpose of using both quantitative and qualitative approaches was to gain multiple different perspectives on the efficacy, engagement, and sustainability of the DNWD Twitter Campaign. Quantitative measurements provide numerical indices that can speak to these metrics. Qualitative data can provide rich themes to help make sense of the results from the quantitative data. Nevertheless, both the quantitative and qualitative measurements are intended to

reveal information about the efficacy, engagement, and sustainability of the DNWD Twitter Campaign (85,86).

To that end, this project included three (3) substudies: 1) a time-series study comparing positive diabetes screening frequencies at two locations (Al Ahsa and Hafr Albatin) before and after the beginning of the DNWD Twitter Campaign, 2) an anonymous survey of Twitter users engaging with the DNWD Twitter Campaign account regarding how the tweets may have impacted their motivation to undergo T2D screening, and 3) semi-structured interviews with government officials and providers at the participating clinics (Al Ahsa and Hafr Albatin) investigating their views on the sustainability of the DNWD Twitter Campaign (see Table 1).

Table 1. Research Questions, Objectives, and Substudies.

Objective and Research Question Number	Research Question	Objective	Substudy
1	What is the comparison of positive screening frequencies before and after implementing the Twitter campaign?	To compare the positive screening frequencies for diabetes before and after the introduction of the DNWD Twitter Campaign intervention.	<u>Substudy 1:</u> A time series study comparing positive diabetes screening frequencies at two locations (Al Ahsa and Hafr Albatin) before and after the beginning of the DNWD Twitter Campaign.

Objective and Research Question Number	Research Question	Objective	Substudy
2	Do Twitter users in Saudi Arabia who are exposed to the DNWD Campaign engage with the tweets, and are they satisfied with the tweets?	To assess measure users' engagement and satisfaction with the DNWD Campaign (15).	<u>Substudy 2:</u> An anonymous survey of Twitter users engaging with the DNWD Twitter account regarding influence on attitudes, perceptions, and behaviour.
3	What are other stakeholders' views on the sustainability of the DNWD Twitter Campaign?	To gauge the sustainability of the DNWD Twitter Campaign	<u>Substudy 3:</u> Semi-structured interviews with government officials and providers at the participating clinics (Al Ahsa and Hafr Albatin) about the sustainability of the DNWD Twitter Campaign.

The second objective of the study was to compare the positive screening frequencies for diabetes before and after the introduction of the DNWD Twitter Campaign intervention. To answer Objective 2, Substudy 1 was conducted. In this substudy, the DNWD Twitter Campaign was implemented, and positive frequencies of diabetes screening at two locations, Hafr Albatin and Al Ahsa, were calculated for both the pre-intervention period and post-intervention period. These localities were chosen because they represent large clinical centers in the Eastern Province that serve a large proportion of the population. For example, in 2013, Hafr Albatin had a total of 1,288,738

health visits, and Al Ahsa had 3,491,509 (74). The catchment area for Hafr Albatin covers a lot of distant towns and regions that include tribes, while the Al Ahsa's catchment area is more urban. It would be unusual for one individual to visit both clinics to receive a T2D diagnosis. However, because the data collected at these clinics are reported in aggregate, it would not be possible to tell if one individual is in the data for both clinics. Further, if they are being treated at a private clinic in the area and chose to come to a public clinic, they would be likely to choose either one of these because they are the only two in the area.

The third objective of the study was to assess users' engagement and satisfaction with the Twitter campaign. Objective 3 was addressed by Substudy 2. In Substudy 2, an anonymous survey was made available to those engaging with the new DNWD Campaign Twitter account to measure level of engagement and satisfaction with the tweets. The thinking was that increased engagement and satisfaction would lead to the content of the tweet impacting the user's motivation to undergo T2D screening. Ultimately, this was the goal of the application of the HBM model – to call the public to action to undergo T2D screening so as not to remain undiagnosed if positive.

Finally, the fourth objective was to explore stakeholders' views on the sustainability of the DNWD Twitter Campaign. Objective 4 was addressed through Substudy 3. Substudy 3 consisted of a semi-structured interview with government officials and provider stakeholders at the clinics at Al Ahsa and Hafr Albatin to determine stakeholders' views on the sustainability of the DNWD Twitter Campaign.

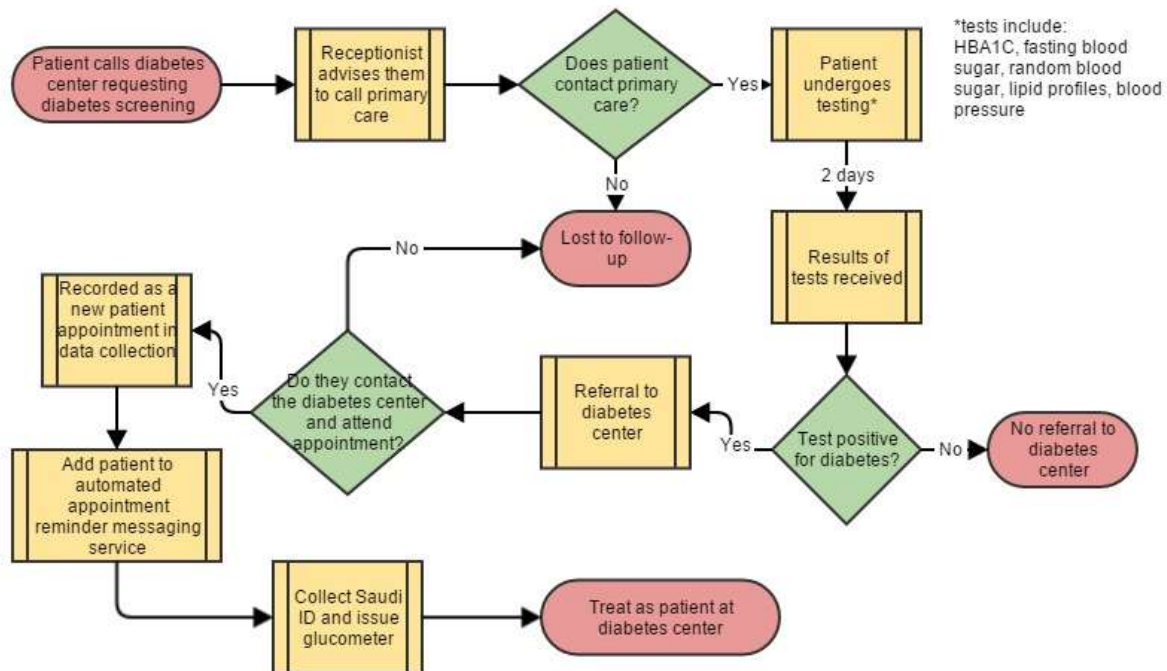
The next section describes each of the substudies in detail. For each substudy, the following information is covered: research design, setting and participants, data collection, data analysis, ethical considerations, and internal and external validity.

3.4 Substudy 1: A time series study comparing T2D screening frequencies at two locations before and after the beginning of the DNWD Twitter Campaign.

3.4.1 Research Design

This was a time series study of monthly incident T2D diagnoses at the two locations, Hafr Albatin and Al Ahsa. Both locations have a diabetes center to where patients are referred when they are diagnosed as having T2D by their general practitioner (GP). Patients seeking T2D screening who contact the diabetes center are sent to their GP for screening, and if they screen positive, they are referred to the diabetes center for treatment and follow-up (see Figure 24).

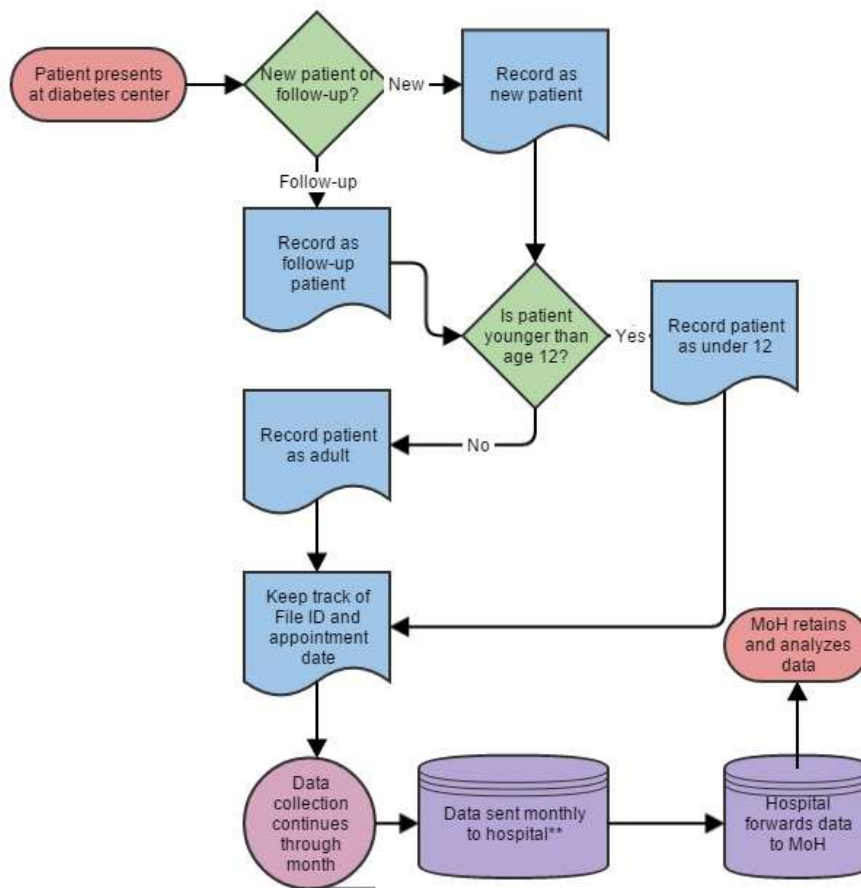
Figure 24. Diabetes Center and GP Clinic Flow for Patients Seeking Diabetes Screening



As shown in Figure 24, it is the GP's office that is responsible for diagnosing the patient. Hence, the diabetes center cannot count the frequency of those presenting for screening; only the GP's office could do that. Since the GP's office does not collect data on this, the diabetes center is the only source of data in this substudy.

Once patients present at the diabetes center, data are collected about each appointment in a book. The data flow is depicted in Figure 25.

Figure 25. Diabetes Center Data Flow



As seen in Figure 25, the data collected about all patients with T2D presenting to the diabetes center at both clinics includes sex, whether or not they are under age 12, and their file ID, which is a clinic-assigned ID.

It is important to note that there is a “functional bottleneck” that essentially ensures that process can provide clean data to this study because of the way the MoH functions and the geographic catchment area for diabetes. Although there are private clinics in this area, these two diabetes centers run by MoH are the main diagnostic centers. Anyone in the geographic area would likely be referred to either of these centers for obtaining a confirmed diabetes diagnosis. Because of this situation, there is expected to be very little data loss. In other words, the monthly reports of number of

new diagnoses coming out of these two clinics is likely to be very close to accurate in terms of the number of new diagnoses in the clinics' catchment area. Because of the arrangement of the medical system, very little slippage is expected.

Monthly, these data from all MOH clinics are aggregated and recorded on a form which is sent to the MOH. On the y-axis of the form are different types of visits, with the first entry being "First visit to D.M. clinic", with D.M. clinic meaning the diabetes center. The cells in the form include "Age Group in Years", and the levels of ages are <1 year, 1-4 years, 5-14 years, 15-44 years, 45-64 years, and 65 years and older. The cells in the form also include number of women and number of men under the category "Non-Saudi", and the number of women and men under the category "Saudi". The actual count is of visits, not individuals, but typically individuals would not visit more than once per month for a screening. The first row of the data from this form for each of the two clinics studied in the Eastern Province will be transferred to the study from the MoH.

3.4.2 Setting and Participants

Two clinics agreed to provide access to screening data for the needs of this project. These clinics are both in the Eastern Province; Hafr Albatin is on the northern side and Al Ahsa is on the eastern side. These two clinics were selected for the following reasons: 1) the student researcher had access to individuals working at these clinics who were interested in participating in this campaign, and 2) these clinics comprise the catchment area for Saudi Arabia's entire Eastern Province. In 2013, the population served by Hafr Albatin is estimated to be 437,349.9 (82% Saudi), and the population served by Al Ahsa is estimated to be 1,193,373 (82% Saudi) (74). A review of the Statistical Book for Saudi Arabia for 2013 reveals that the number of primary

healthcare visits that took place at Hafr Albatin was 1,099,278, and a total of 3,040,033 were at Al Ahsa (74).

When patients present at the clinic with suspected diabetes, the clinician orders a diabetes screening. If the patient is found to be diabetic, she or he is referred to the center. The Director of the diabetes center reported that on average, the center receives approximately 250 referrals per month, indicating that 250 newly diagnosed diabetics are identified weekly at this clinic. In November 2015, the center received 1,959 referrals, and in December, it received 1,881 referrals. For the entire calendar year of 2015, the center recorded 17,056 newly identified cases of diabetes. The Director of the center reported that his clinic estimated the prevalence of diabetes in the area served by the Hafr Albatin clinic, and it was found to be very high: 31%.

A question may be raised as to whether or not these clinics can accept a sharp increase in referrals. Currently, the clinic has much more capacity to treat patients, and is encouraging people to come in and get diagnosed and treated. The MoH is aware of the problem of undiagnosed and untreated diabetes, and has therefore developed these clinics with far greater capacity than is being used currently. Even an eventual doubling of diagnoses per month could be accommodated by this well-planned and well-integrated system.

3.4.3 Data Collection

As described above, data on diabetes centre visits at each MoH clinic are continuously collected from all MoH clinics per MoH policies. These data are analysed by MoH monthly, but are available at any time for the purposes of this study. Data are gathered about frequencies of screens by month.

First, historical data were requested from both Hafr Albatin and Al Ahsa to establish background frequencies of screening. Data were requested for 12 months prior so background rates could be analyzed. It was found that the data were not being routinely backed up; yearly frequencies were available, but data for monthly frequencies was not always backed up. Hence, both clinics provided as much monthly data as possible about frequencies of positive diabetes tests at their clinics, and when monthly data were not available, yearly data were provided.

3.4.4 Data Analysis

At the time of collecting old research reports from previous months and years during the study, the MoH had already used the information on the reports, so yearly reports were available, but not monthly reports. Yearly aggregate results were available from both clinics for the years 2015 through 2018, but monthly reports were not available for this extended time period. The work process at the clinics is to keep weekly statistics manually, then aggregate these into monthly reporting. At Hafr Albatin, the monthly reports that were submitted were not able to be located, but back-ups of weekly reports were kept in PDF format and were supplied to the researcher, who conducted data entry to create monthly data. Data were available starting in November 2017, which coincides with the launch of the DNWD Campaign, through December 2018. At Al Ahsa, the monthly reports were available, so they were supplied to this researcher who conducted data entry. Again, data were only available for the time frame of November 2017, through December 2018.

The availability of data restricted choices for analysis. A segmented regression analysis proposed by Wagner and colleagues was originally planned to be used to

analyze and compare the pre- and post-intervention periods (87). This approach is also recommended by Lopez Bernal and colleagues (88). However, due to the fact that no data were available in the pre-intervention period, this segmented regression cannot be done.

An “interrupted time series” or ITS analysis had been considered originally as well. An important point should be made about the nature of the Twitter campaign. This study is a time series, but cannot be seen as an ITS design, because the Twitter campaign itself was deliberately not homogenous over time in a constant force, the way a policy change or a new drug being released on the market would be. In ITS terms, pre-intervention refers to the period before the law or policy change, and post-intervention refers to the period after this discrete time point. Bernal Lopez et al. give the example of studying acute coronary events (ACEs) in Italy before and after an outdoor smoking ban (88). The question was whether or not the smoking ban led to a lower rate of ACEs, and the answer was not clear by simply looking at monthly rates before and after the ban. Hence, segmenting the periods into pre-intervention and post-intervention and running a regression was helpful for answering this question (88). By contrast, in this study, the Twitter campaign was not constant; as the researcher gained experience, he adjusted the Twitter campaign to improve targeting to become more effective over time. The start of this intervention was therefore unlike the start of a new policy or new law. For this reason, the “post-intervention” period for the Twitter campaign was deliberately inconsistent, and this would invalidate an ITS analysis. As it turns out, since there were no data available for analysis in the pre-intervention period, and ITS analysis is not possible with these data.

The lack of pre-intervention data also invalidates the use of an autoregressive integrated moving average (ARIMA) (88). Further, ARIMA is used for forecasting, and the MoH is not interested in forecasts. If the intervention appears to work, it will need to be funded constantly, and hopefully improved to be optimal. This situation therefore invalidates the need for forecasting. For these reasons, the final analysis consists of only a descriptive analysis. Because no pre-intervention data were collected, it is not possible to use statistical tests to estimate the impact of the intervention.

3.5.6 Ethical Considerations

This study was approved as an “exempt” study by the MoH IRB on March 27, 2018 (see Appendix C).

3.5 Substudy 2: An anonymous survey of Twitter users engaging with the DNWD

Twitter Campaign account regarding engagement and satisfaction.

3.5.1 Research Design

A survey was developed and programmed into SurveyMonkey, a web-based online survey tool (89). The survey did not ask any identifying information. Ethnicity was asked, but because KSA has a population of approximately 33 million people where 37% of the population is “non-Saudi” with the rest being “Saudi”, asking for ethnicity could not have led to the re-identification of the respondent (90,91). The survey was tweeted out as an internet link to NDPCP account followers approximately six months after the beginning of the DNWD Twitter Campaign, and measured engagement and satisfaction. This section describes this survey, and how it was developed, administered, and analyzed.

3.5.2 Setting and Participants

The intention was to survey Twitter users who were regular readers of the NDPCP account's tweets. Therefore, the following eligibility criteria for the survey were set up:

1. Respondent must state that they are able to understand conversational written Arabic very well, because the survey is in Arabic.
2. Respondent must state that they currently live in KSA, because the target population for the survey is KSA residents.
3. Respondent must state that at least one of their current Twitter accounts are following the NDPCP account. This is to ensure that the user is exposed to the NDPCP tweets.
4. Respondent must state that they read at least one of the DNWD Twitter Campaign tweets. That is because the survey is about their reaction to the content of the tweets.

Once users clicked on the survey link, they were brought to a series of qualifying questions. Those who did not meet the criteria were forced to exit the survey.

3.5.3 Survey Development

Initially, the survey was to be developed around domains which were identified from the literature review of social media use for engagement in public health or health activities, as well as studies about encouraging T2D and other chronic disease screening using traditional public health methods. Questions were developed around these domains. The researcher's advisory panel recommended to the researcher to select questions off of several different domains to include, and to delete others. The

advisory panel also added some questions. After this was done, domains were back-engineered from the remaining questions. This process left four domains: qualification questions, demographics, satisfaction with tweets, and engagement with tweets. In addition, questions about screening were added so the researcher could quantify whether the campaign succeeded in motivating respondents to obtain T2D screening or not.

Because this survey was not developed according to a set of domains, validity could not be assessed using confirmatory factor analysis (CFA) (92–94). There were also no reliability tests built into the design for this reason, which means that a Cronbach's alpha would not be a valid measure of reliability (92–94). The first 30 surveys were sent to a convenience sample of KSA professionals known to the researcher who qualified for the survey for testing; once it was determined that the survey was collecting data accurately, the researcher opened up data collection to all Twitter users who qualified for the survey.

The survey was developed around the following domains: qualification questions, demographics, satisfaction, and engagement (37). For demographics, age, gender, marital status, ethnicity, region of residence in KSA, nearest MoH Diabetes Center in KSA, current T2D status, and how often the user uses Twitter were gathered (see Appendix D). For satisfaction and engagement questions, several Likert scale questions were developed about satisfaction and engagement with the NDPCP tweets. Respondents were also asked whether they had been screened for T2D since November 2017, and if so, their motivations for being screened.

The survey translated into Arabic, then back-translated into English, and troubleshooting took place where there were translation issues to improve the clarity of the Arabic. Once this was complete, the Arabic version of the survey was programmed into SurveyMonkey and a link set up for tweeting.

3.5.4 Data Collection

The DNWD Twitter Campaign began on November 15, 2017. Between July 30 and September 19, 2018, NDPCP account tweeted out anonymous link to survey approximately 20 times, and pinned a tweet with the survey link to the NDPCP Twitter account profile.

3.5.5 Data Analysis

The analysis of data for Substudy 2 was done in R (95). A descriptive analysis of the responses to the questions in the survey was conducted. First, the questions on the demographic domain, which were all categorical, were analyzed. Distributions (total sample and percentage) were developed for the answers to all questions. Bivariate distributions were developed comparing respondents who reported having T2D or pre-T2D vs. those who did not report having T2D. Next, categorical questions asked about engagement were analyzed in the same fashion, with first distributions in the dataset developed, followed by a bivariate analysis stratified by T2D status. Third, categorical questions about satisfaction with tweets were analyzed in the same way, with overall dataset distributions, and distributions by T2D status. Descriptive analysis was also conducted about the screening questions. Bar plots were made using the package ggplot2 (96).

Likert scale questions had been included for both the engagement and satisfaction domains. For all Likert scale statements, the respondent was asked to evaluate the statement using the following scale: Strongly disagree (1), somewhat disagree (2), neither agree nor disagree (3), somewhat agree (4), and strongly agree (5). On each of the two domains, 14 statements were included, 11 of which were positively coded (meaning an answer of 5 was a positive answer), and three of which were negatively coded (meaning an answer of 1 was a positive answer). All variables were kept in their original coding and were visualized in a plot using the Likert package for interpretation (97).

3.5.6 Ethical Considerations

This study was approved as an “exempt” study by the MoH IRB on March 27, 2018 (see Appendix C).

3.6 Substudy 3: Semi-structured interviews with government officials and healthcare providers investigating their views about the DNWD Twitter Campaign.

3.6.1 Research Design

After the DNWD Twitter Campaign had been in place for eight months, a group of stakeholders were interviewed and asked about project design and implementation factors, factors in the organizational setting, and factors in the broader community environment, mainly to gauge sustainability (98). These interviews were recorded and analyzed for themes to inform the future of the Twitter campaign (99). The details of this qualitative study design are included below.

3.6.2 Setting and Participants

Purposive sampling was used (100). It was determined that the eligibility criteria for participating was to be a member of one of the following stakeholder groups at either the Al Ahsa or Hafr Albatin diabetes center: A nurse who treats T2D patients, an NDPCP official, or a physician who treats T2D patients. Only one NDPCP official was available at each location, but there were several nurses and physicians available. A total of 12 stakeholders were interviewed. At each location, three nurses, one NDPCP official, and two physicians were interviewed, for a total of six at each location.

First, this research obtained the contact information for the only NDPCP official at each location. The researcher contacted these individuals by e-mail and set up a meeting for the author to visit the location in person. When the author arrived, the NDPCP officials agreed to be interviewed, and the interview took place. In order to qualify to be interviewed as an NDPCP official, they had to be employed as the NDPCP official at that location.

Next, each official was told that the author wanted to also interview three nurses that worked at the clinic in diabetes, and also, two physicians who worked at the clinic in diabetes. Both officials at that time inquired to clinical departments for volunteers. Three nurses and two physicians at each location volunteered to be interviewed, and were subsequently interviewed. The six volunteers from Hafr Albatin were interviewed later over the phone, while the volunteers from Al Ahsa were interviewed immediately in person.

3.6.3 Data Collection

The researcher interviewed the six participants from Al Ahsa in person. At Hafr Albatin, the student interviewed the NDPCP official in person, and the other five participants over the phone. The student obtained oral consent from all 12 participants. Oral consent was used to protect the identity of the participants so they could speak freely about the DNWD Campaign without fearing that there may be retaliation from their job or supervisor.

If the potential participant wanted to participate, after they provided consent, they were asked interview questions over the phone or in person that were recorded (see Appendix E for questions). If the interview was in person, the researcher sat in a private office during the interview, and encouraged the participant to choose a private environment where they could not be heard by others. The recording was done on an independent dictaphone, then transferred to a computer that was not connected to the internet for transcription and analysis. The audio file was identified by study number only, and no private information was included. The audio file was translated from Arabic to English and transcribed by a commercial transcription and translation service. The service was not accurate in areas due to accents, so the researcher had to go over the transcriptions and edit them until they were accurate.

Strict precaution was put into place during the study to prevent the audio files or the transcripts from being disclosed inappropriately. The audio records files were kept in a secure, locked location. Only authorized persons had access to transcriptions, notes, and other related records.

The number of individuals who were originally targeted to be studied was 12, which is an appropriate number for qualitative research. The goal of qualitative research is to determine themes (101–104). It is commonly accepted in qualitative research that all themes have been identified when a point of saturation is reached, meaning additional interviews do not reveal additional themes that have not already been identified (103,104). Predicting the necessary sample size for reaching saturation is difficult, but Guest and colleagues conducted an experiment that suggested that most high-level themes that will be identified in any study will be present in the first 12 interviews (103). In addition, the WHO provides guidance as to the number of interviews required in qualitative data collection and analysis, and emphasizes that a large sample size should not be the focus, but instead, the goal should be to aim for “information richness of the cases selected” (105). Hence, WHO says that qualitative comparative studies generally have ten participants in each group (106).

In this case, there were very few people available for interviews, as there are only two diabetes centers participating, and only a small team was assigned to help the student with the DNWD Twitter Campaign. Also, a representative group of clinicians and NDPCP officials were selected for interview. This is why ultimately only eight were interviewed.

3.6.4 Data Analysis

In the analysis of qualitative data in multi-disciplinary health research, the overall approach called the “framework method” has been advocated (107). The framework method generically refers to a method of analyzing qualitative data to produce themes (e.g., a conduct a thematic analysis) using what is called an “analytic framework”, or the

development of a system of codes and categories that relate together thematically (107). Finally, the analytic framework should be expressed in a matrix that ties together these themes (107).

The framework method is flexible, in that it allows for the researcher to develop a matrix based on any type of analytic framework, the process of conducting an analysis according to the framework method is relatively fixed (107). These steps can be described as “stages”. In Stage 1, as soon as the qualitative data are recorded, they are transcribed. In Stage 2, the researcher rereads the transcripts so as to familiarize themselves with the content of each interview (107). In Stage 3, “coding” takes place; this is where each idea expressed in the interview is given a code linking it to a theme expressed. There are multiple ways to go about coding a transcript, and there are advantages and disadvantages of each (107). Once the coding is done in Stage 3, in Stage 4, the codes are assembled into an analytic framework. Steps 5 and 6 have to do with developing a final matrix to express a chart of the final themes included in the analytic framework, and Stage 7 is to interpret this final matrix (107).

For the analysis, the framework method was used. In Stage 1, data were recorded and transcribed, and in Stage 2, transcripts were reviewed (107). For Stage 3, themes were summarized using an inductive approach. An approach recommended by Burnard and colleagues called thematic content analysis for analyzing qualitative data in health fields to derive themes was used as a guide for coding in Stage 3 (99). This approach, which arose out of grounded theory, entails hand-coding data into an initial framework, and then assembling the initial coding frameworks into a final coding framework (99). This guidance was used to develop the final chart of themes and

subthemes (under Stages 5 and 6) (99,107). The final analytic framework was expressed in this chart of themes and subthemes, and for Stage 7, this chart was interpreted. From the subclassifications in the final coding framework, a word cloud was developed in R using the wordcloud package (108).

3.6.5 Ethical Consideration

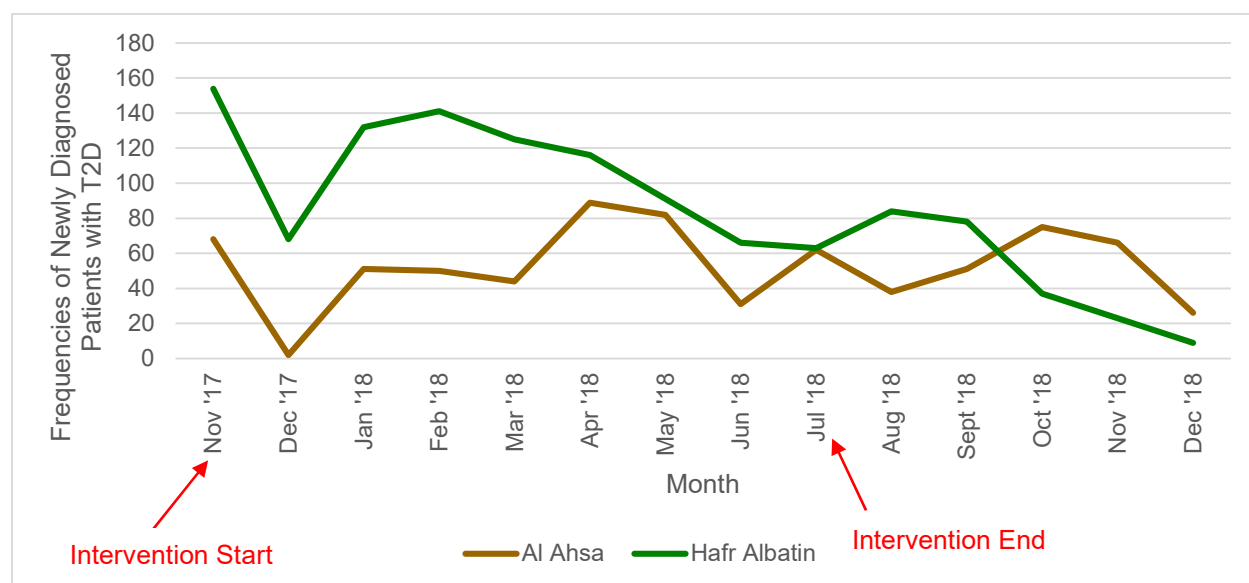
Individuals interviewed in this study were not asked about personal information. Instead, they were asked about their opinions about the DNWD Campaign and its sustainability. Substudy 3 was approved as an “exempt” study by the MoH IRB on March 27, 2018.

4.0 Results

4.1 Substudy 1 Results

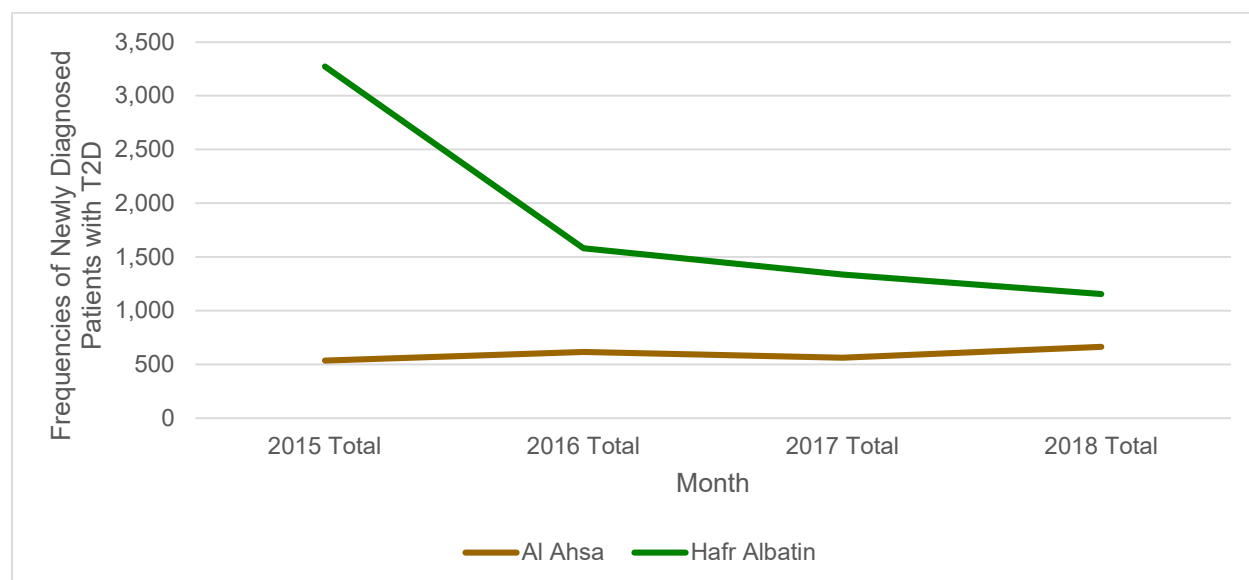
The data available consisted of monthly frequencies of newly diagnosed T2D patients presenting for their first visit at the diabetes centers in Al Ahsa and Hafr Albatin from November 2017 through December 2018, and yearly frequencies for 2015 through 2018. These are presented in Figures 26 and 27. On Figure 26, the months of starting and ending the DNWD Twitter Campaign are marked.

Figure 26. Monthly Frequencies of Newly Diagnosed Patients with Type 2 Diabetes Presenting at Al Ahsa and Hafr Albatin Diabetes Centers for their First Visit, November 2017 through December 2018



T2D = Type 2 diabetes.

Figure 27. Annual Frequencies of Newly Diagnosed Patients with Type 2 Diabetes Presenting at Al Ahsa and Hafr Albatin Diabetes Centers for their First Visit, 2015 through 2018.



T2D = Type 2 diabetes.

Unfortunately, Figures 26 only visualizes the time period after the DNWD intervention started. Both figures extend past the end of the intervention in July 2018. In terms of a monthly interpretation, Figure 26 is very hard to use to estimate any ecological associations between frequencies of T2D screenings and the DNWD Twitter Campaign without more context, such as monthly frequencies over several previous years. Figure 27 suggests that the 2017 frequencies and the 2018 frequencies were not much different at each clinic. Since the DNWD Twitter Campaign took place during the last two months of 2017 and the first seven months of 2018, it is also hard to interpret the experience of this campaign and compare it to the experience at the diabetes clinics using these figures.

Had the researcher been convinced the data were both accurate and clear, and a rising trend been shown, this would not have necessarily indicated that there was a link between the DNWD Twitter Campaign and the rise in screenings. This is because this is an ecological or correlational comparison. It is possible that T2D screening frequencies may be rising naturally in the background, and that the DNWD Twitter Campaign going on at the same time would not have impacted this. The ecological study design does not allow for causal inference. Even so, the lack of usable data prevents any consideration of results from this ecological analysis.

4.2 Substudy 2 Results

As a reminder, Substudy 1, which was just presented, represents a time-series analysis of frequency of T2D diagnoses at two diabetes centers in KSA. The analysis was challenging because of difficulty with the underlying data. Nevertheless, it was unclear from the findings whether any increases in frequency of T2D screening took

place during the time period of the DNWD Twitter Campaign. The researcher had hoped to see an ecological association between the two, no matter how weak, but this was not shown in the analysis.

Substudy 2 was of a different study design. It was a cross-sectional online anonymous questionnaire that was administered to followers of the NDPCP Twitter account at the end of the DNWD Twitter Campaign. A total of 796 surveys were completed during the data collection period and available for analysis. Table 2 shows the demographics of respondents.

Table 2. Demographics of Respondents to Twitter User Survey.

			T2D* Status	
		All	T2D or Pre-T2D	Non-T2D
Category	Level	n (%)	n (%)	n (%)
All**	All	796 (100%)	256 (32%)	540 (68%)
Gender	Male	496 (62%)	209 (82%)	287 (53%)
	Female	300 (38%)	47 (18%)	253 (47%)
Age Group	< 25 years	39 (5%)	2 (1%)	37 (7%)
	25-34	172 (22%)	40 (16%)	132 (24%)
	35-44	260 (33%)	76 (30%)	184 (34%)
	45-54	200 (25%)	78 (30%)	122 (23%)
	55-64	101 (13%)	52 (20%)	49 (9%)
	65+	24 (3%)	8 (3%)	16 (3%)
Marital Status	Single	59 (7%)	13 (5%)	46 (9%)
	Married	683 (86%)	223 (87%)	460 (85%)
	Divorced/ Widowed	54 (7%)	20 (8%)	34 (6%)
Region	Al-Riyadh	334 (42%)	125 (49%)	209 (39%)
	Makkah	83 (10%)	18 (7%)	65 (12%)
	Al-Madinah	23 (3%)	4 (2%)	19 (4%)
	Al-Qaseem	33 (4%)	6 (2%)	27 (5%)
	Eastern Province	198 (25%)	88 (34%)	110 (20%)
	Aseer	34 (4%)	4 (2%)	30 (6%)

			T2D* Status	
		All	T2D or Pre-T2D	Non-T2D
	Tabouk	26 (3%)	1 (0%)	25 (5%)
	Hail	13 (2%)	1 (0%)	12 (2%)
	Northern Borders	15 (2%)	2 (1%)	13 (2%)
	Jazan	7 (1%)	0 (0%)	7 (1%)
	Najran	9 (1%)	2 (1%)	7 (1%)
	Al-Baha	10 (1%)	3 (1%)	7 (1%)
	Al-Jouf	11 (1%)	2 (1%)	9 (2%)
T2D status	T2D	63 (8%)	63 (25%)	0 (0%)
	Pre-T2D	193 (24%)	193 (75%)	0 (0%)
	Non-T2D	540 (68%)	0 (0%)	540 (100%)
Closest Ministry of Health Diabetes Center	Ahsa	122 (15%)	53 (21%)	69 (13%)
	Riyadh	367 (46%)	124 (48%)	243 (45%)
	Taif	30 (4%)	6 (2%)	24 (4%)
	Jeddah	150 (19%)	27 (11%)	123 (23%)
	Makkah	37 (5%)	6 (2%)	31 (6%)
	Hafr Albatin	84 (11%)	35 (14%)	49 (9%)
	Don't Know	6 (1%)	5 (2%)	1 (0%)
Screening behavior since November 2017	Got screened	755 (95%)	247 (96%)	508 (94%)
	Did not get screened	8 (1%)	4 (2%)	4 (1%)
	Unknown	33 (4%)	5 (2%)	28 (5%)

*T2D – Type II diabetes.

** This first row shows the distribution of sample by diabetes status. The rest of the rows present column percentages.

As shown in Table 2, overall, males made up a larger percentage of respondents than females (62% vs. 38%). Notably, among those with T2D or pre-T2D, the percentage of males was much higher than females (82% vs. 18%), while among those without T2D, the percentage of males was closer to the percentage of females (53% vs. 47%). Most respondents were between the ages of 25 and 64 (92%), and older age groups had larger proportions of males compared to females. Almost all respondents were married (86%).

Geographically, most respondents were either from Al-Riyadh (42%) or Eastern Province (25%). The diabetes center in Riyadh was the closest diabetes center for almost half the respondents (46%), with the next most popular closest center being in Jeddah (19%). The next two most popular centers, Al Ahsa (15%) and Hafr Albatin (11%) are both in Eastern Province.

In terms of clinical status, most of the respondents did not have T2D (68%). However, among all groups, a very large proportion were screened for T2D since the beginning of the DNWD Twitter Campaign. Among those with T2D or pre-T2D, 96% were screened since the beginning of the campaign, and among those without T2D, 94% were screened since the beginning of the campaign.

In terms of responses to questions about engagement, most respondents (n = 679, 85%) said they used Twitter more than once per day. Thirty-eight percent of respondents (n = 305) reported searching for the DNWD hashtag one time, and half (n = 396, 50%) reported searching for it two or more times. Over a quarter (n = 206, 26%) reported mentioning the NDPCP Twitter account at least one time, and another quarter (n = 192, 24%) reported mentioning it two or more times. In addition, 81% (n = 642)

reported retweeting at least one DNWD tweet, 80% (n = 635) told at least one family member information from a DNWD tweet, and 55% (n = 434) told at least one friend or non-relative about information in a DNWD tweet.

Satisfaction data were gathered on a Likert scale. The results are visualized in Figure 28.

Figure 28. Reported Satisfaction with DNWD Twitter Account and Tweets.

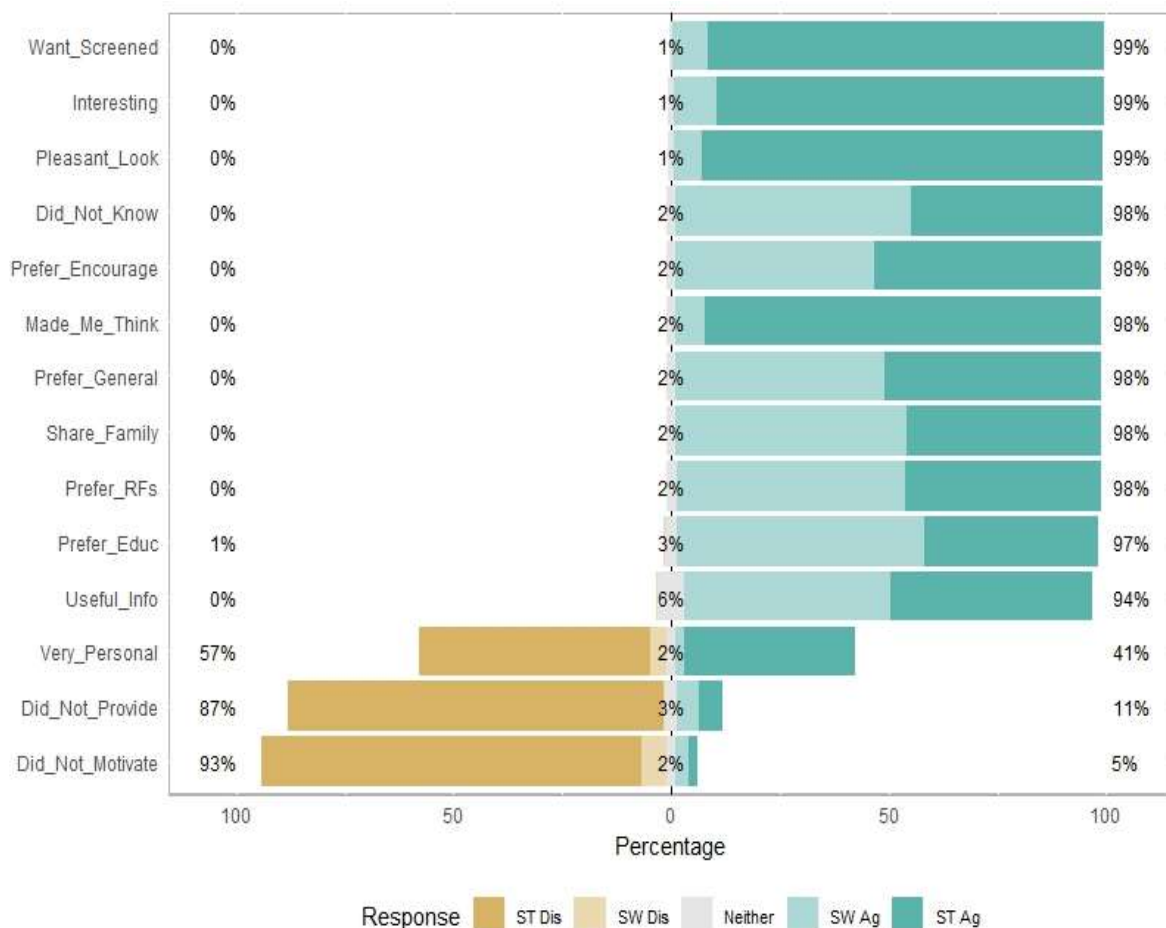


Figure abbreviations:

Want_Screened Tweets made respondent want to get screened for T2D

Interesting Tweets were interesting

Pleasant_Look Tweets pleasant to look at and read

Did_Not_Know	Tweets provided information respondent did not know
Prefer_Encourage	Preference for tweets that encourage respondent to get T2D
Made_Me_Think	Tweets made respondent think about ways to reduce risk factors
Prefer_General	Preference for tweets that provide general information on T2D
Share_Family	Tweets provided information respondent can share with family
Prefer_RFs	Preference for tweets about risk factors and symptoms of T2D
Prefer_Educ	Preference for tweets that provide T2D education
Useful_Info	Tweets provided useful information about what to do if respondent suspects they have T2D
Very_Personal	Tweets were very personal
Did_Not_Provide	Tweets did not provide the information respondent was looking for
Did_Not_Motivate	Tweets did not motivate respondent to seek T2D screening

The Likert figure displays the percentage of responses on all five levels of the Likert scale: Strongly disagree (depicted in dark gold), somewhat disagree (depicted in light gold), neither agree nor disagree (depicted in grey), somewhat agree (depicted in light green), and strongly agree (depicted in dark green). As can be seen in the figure, down the middle vertical, there is a list of percentages. These represent the percentage of respondents answering “neither agree nor disagree”. Along the right side of the figure are the proportions of those saying “somewhat agree” or “strongly agree”. The total percentage of those groups combined is reported on the right margin for each statement. Similarly, the percentage of “somewhat disagree” and “strongly disagree” groups combined is reported on the left margin for each statement. Along the y-axis are

shortened descriptors referring to the statement, and below the figure is a key to the full statement. The Likert figure is sorted in order of the statement with the highest percentage of “somewhat agree” and “strongly agree” combined at the top.

Per Figure 28, respondents overall were satisfied with the tweets. Between 94% and 99% agreed they were satisfied with many aspects of the tweets including the pleasant way they looked, their interest in the information provided, and the usefulness of the information provided. In terms of the two negatively-worded questions, 11% agreed that the tweets did not provide information the respondent was looking for, and 5% agreed that the tweets did not motivate them to seek T2D screening.

Respondents who reported being screened between November 2017, when the Twitter campaign started, and the time of the user survey were also asked about motivations for screening. Of the 755 individuals who reported being screened since the beginning of the intervention, most (87%) were motivated by the tweets from the NDPCP Twitter account. This was by far the most common answer, more than twice the frequency of “other reason”, “risk factors” and “symptoms”.

4.3 Substudy 3 Results

As a reminder, Substudy 1 was a time-series analysis of the frequency of diabetes screenings at two screening centers. The researcher had hoped to see increases in diabetes screening frequencies during the period of the DNWD Twitter Campaign, but complications with the underlying data prevented an accurate analysis. Next, the results of Substudy 2, which was an online survey of followers of the NDPCP Twitter account, found that respondents were both engaged and satisfied with the

tweets sent by the account, and they reported that the tweets encouraged them to present for screening for T2D.

Substudy 3 is a different study design than Substudies 1 and 2. Substudy 3 was a qualitative study where government officials and clinicians were interviewed about their opinions about the DNWD Twitter Campaign, and a thematic analysis was done. A total of 12 participants were interviewed; Table 3 provides a breakdown of interviewees by role and location.

Table 3. Total Interviewees by Role and Location

Location	NDPCP Officials	Nurses	Physicians	Total
Al Ahsa	1	3	2	6
Hafr Albatin	1	3	2	6
Total	2	6	4	12

As shown in Table 3, one NDPCP official was interviewed from each location (total n = 2), three nurses from each location were interviewed (total n = 6), and two physicians from each location were interviewed (total n = 4). As described in the methods, each interview was recorded, transcribed, and coded using an initial coding framework (99).

After all interviews were coded, a final coding framework was developed, which is present in Table 4

Table 4. Final Coding Framework

Classification	Subclassification
Campaigns	Campaigns aimed at all demographics
	Campaigns that use traditional media
	Centrally-coordinated campaign
	Comparison to other campaigns

Classification	Subclassification
	Comparison to smoking campaigns
	Continuous, ongoing campaign
	Health education campaigns
	Increased awareness of diabetes
	In-person necessary for some public health
	MOH campaigns should be unfunded and voluntary
	MOH lends legitimacy to campaigns
	Negative response to campaign
	Positive response to Twitter campaign
	School-based prevention education
	Sports leaders to target adults
	Targeting subgroups
	Traditional public health campaigns
Diabetes-specific	Age as risk factor for diabetes
	Children with diabetes
	Comparison to other diabetes campaigns
	Diabetes associated with other chronic diseases
	Diabetes diagnoses
	Early diagnosis of diabetes
	Early intervention for diabetes
	People with high risk for diabetes
	Undiagnosed diabetics believing they may have disease
Health Information	Correct inaccurate health information
	Diabetes requires an interdisciplinary health team
	Disseminating expert opinion
	Health information seeking behavior
	Personal interaction sharing knowledge
	Provide accurate health information
Policy-related	Clubs for exercise and health
	Comparison to other countries
	Consistent with MOH policies
	Diabetes statistics
	Health policy/guidelines
	Healthcare resources/capacity
	Medicalization of the population
	Public health for prevention
	Reaching public health benchmarks
	Reduce healthcare costs
	Saudi Arabia is unique

Classification	Subclassification
Promotion	Cartoon characters to target children
	Comedians to target adults
	Doctors to target adults
	Famous character to target children
	Female leaders to target women
	MoH official to target adults
	Religious leader to target adults
	Social media influencer for targeting adults
	Use child with diabetes for targeting children
	Use famous characters in campaigns
Social Media	Comparing social media
	Easier to update information in social media campaign
	Easy to use social media for campaigns
	Good that MoH supports social media campaigns
	Low cost intervention
	Motivating people to do diabetes screening with social media
	Problems with social media
	Reach large audience on social media
	Social media campaigns are successful
	Social media helps health information navigation
	Social media in different countries
	Social media limits audience to just people on social media
	Social media more efficient than traditional public health interventions
	Social media platform choice
	Twitter attracts intellectuals
	Twitter effective at targeting
	Twitter targets young people
	Vary format of tweets

Table 4 represents the final matrix that is to be derived when using the framework approach (107). As can be seen in Table 4, the interviews yielded six main classifications: Campaigns, diabetes-specific, health information, policy-related, promotion, and social media. These main classifications yielded 71 subclassifications (see Table 4).

To summarize the results in a different way, several word clouds and a mind map were generated (figures not shown) (63,109). Words most commonly appearing in the word clouds developed included diabetes, health, campaigns, and social media. In their book on how to do high quality qualitative research, Aurini and colleagues (110) recommend additionally generating a mind map as a figure representing the results of the framework methods. Mirroring the thematic results, in the mind map generated, there were six main themes relating to sustainability that arose from the thematic analysis of interview transcripts. Each these is attached to different numbers of subthemes, so these were added to the mind map. As shown in Table 4, the theme with the largest number of subthemes (n=18) was Social Media, and the one with the smallest number of subthemes (n=6) was Health Information. These subthemes were also added to the mind map. Upon reflection of the mind map, it became clear that the main themes are the drivers of the sustainability dialogues. Each main theme had many subthemes, and these were relatively balanced, which is consistent with Table 4.

4.3.1 Project Design and Implementation Factors

Under this domain, there were four questions relating to the interviewee's involvement in the design, thoughts on the goal of the DNWD campaign, thoughts on making the Twitter portion a permanent part of the DNWD campaign, and perception of effectiveness.

With respect to these questions the NDPCP officials answered very differently. One of them was very concerned about resources should the campaign succeed, because then more people would be diagnosed, and the health system would be stressed.

“So you preach [to] people, and people who are not specialists really make you tired. ... When you tell people to go for an examination and they find out that they are a diabetic or pre-diabetic patient, they will be terrified. They will go to different hospitals causing it to be occupied and so on. [My colleague] was trying to prevent smoking in the same manner. So he just stopped his program and put all his effort to establish clinics all over the kingdom, Saudi Arabia. After there was only 1 clinic for smoking; there are now 12 clinics.”

The other NDPCP official saw more use for the campaign. Although he pointed out that treatment must be done by a specialized team, he saw the utility of the Twitter campaign, especially in disseminating correct information.

“For the campaign to continue, it should be updated. It should fight public rumors. For example, some people say that honey doesn’t increase blood sugar. Other people are being treated using herbs and things that are not medically approved.”

One of the nurses also made the same point about needing a specialized team for coaching those developing the information in the campaign material, including the tweets:

“It is known that diabetes needs many specializations to deal with it. We need a doctor to make people aware, diabetes intellectuals to make people aware too, a nutrition specialist, a diabetic foot doctor, and an ophthalmologist because all of these fields are related to

diabetes. So, it is important to have specialists in those fields. Every specialist will give advice according to his field.”

All the nurses interviewed made practical points about implementation. One nurse felt that using Twitter only reaches intellectuals:

“Most Twitter users are actually intellectuals. They have intellect. Many also low IQ people will use some programs. But Twitter is the most advanced.”

But then, she went on to say that this was a good thing, because Twitter can be used to influence intellectuals who then influence less-educated people. Another pointed out that she felt the people on Twitter are the ones who need to be reached with this campaign.

“Community and age group categories at the same time. I mean the follow-up category to Twitter who is exposed to the risk of developing type 2 diabetes are 18 to 50 or 60 years old. Let’s say they are the people that follow Twitter the most.”

However, a common theme was that the Twitter campaign could not replace the other components of a public health education and promotion campaign, but could complement them. One nurse described her work on the DNWD campaign, where they made an educational video and showed it in the community:

“We visited an orphanage, a social development center, and a university, and we participated in campaigns made by the Ministry of Education, in schools... It was a very good purpose. It was good for the

people like teachers, intellectuals and students. The campaign only missed the people who have low awareness. It was a very good initiative from the Ministry of Health. And it was a very good video, actually.”

The physicians interviewed saw some efficiency in the Twitter campaign:

“One of its advantages is the quick spread and the reaching among people. We made many field campaigns which needed a lot of effort, had many costs, and took much time, Twitter actually saves all of these things.”

“Twitter is ideal to raise awareness and to help with early diagnosis; otherwise, field campaigns or visiting clinics are more effective and of benefit for already diagnosed patients.”

However, they recognized that Twitter could not replace other components of the campaign, especially with the patient in the transition from participating in the campaign to becoming a diabetes patient. Again, this brings up funding issues for both the campaign and for resources in the healthcare system. As said by one of the physicians interviewed:

“I think both ways are needed. if the Ministry wants a comprehensive awareness campaign, it should allocate a budget for television and road advertising to target all age groups.”

4.3.2 Factors Within the Organizational Setting

Two questions were asked about factors within the organizational setting, focusing on how well the DNWD Twitter Campaign fits within the MoH organization, and who should be the public face of this campaign. In terms of how well the campaign fits within the MoH organization, all of the interviewees saw a generally good fit, but pointed out some caveats.

First, there were topics where interviewees saw a Twitter campaign like the DNWD fitting seamlessly into existing MoH operations, and these included forming special teams around the campaign, providing training to campaign participants, and organizing volunteer teams with public health messages appropriate to the season (e.g., Ramadan). For example, one of the physicians from Hafr Albatin said:

If [the MoH were to] add more money to the budget to support such a campaign and assign special team for it, and then train staff, yes, it fits with our exciting health promotion programs, when there is already leadership help and a budget from the MoH.

Others felt that even though a Twitter campaign at this time might not fit perfectly within the MoH health promotion framework, they generally agreed that the time had come where MoH needs to build out its infrastructure for doing social media campaigns alongside traditional health promotion. This would require rethinking exactly how to do public health campaigns when deploying them over social media. One participant, the NDPCP official from Al Ahsa, explained how traditional diabetes campaigns are stratified, with different messages aimed at different groups (e.g., pre-diabetics

compared to chronic diabetics). How this would need to play out online in social media would need to be figured out.

Even so, overwhelmingly, the response from participants was that social media public health campaigns have become essentially standard tools in the public health promotion toolbox, and therefore, the MoH will need to adjust to make sure these campaigns can be deployed effectively alongside traditional campaigns. One nurse from Al Ahsa made this point:

I mean, the Crown Prince Mohammed bin Salman declared that 70% of youth in the country are interested in social media. So, to choose Twitter for reaching people – actually, it's the perfect and fastest way to reach the young generation.

Two different participants emphasized that social media campaigns are already in line with existing MoH initiatives, and importantly, could potentially result in reaching larger audiences and being more effective than traditional campaigns. Here are a few quotes from the interviewees on this topic:

It's good because the information reaches the largest proportion of the community with the lowest costs. There is an interaction in questions, responses and sharing the answers.

This is an abbreviated way of targeting a large population, which in the end can give big results.

The Ministry wants a cheap, affordable way to run awareness campaigns, so it should allocate a budget for television and road advertising to target all age groups, but should also consider a different platform for future campaigns.

The next question in this category was who should be the public face of such a public health promotion campaign. Many ideas were put forth: religious people who could carry the message to mosques and religious gatherings, social media influencers, newspaper reporters, television personalities, actors and sports personalities of good character, and comedians. Interviewees indicated that these types of spokespeople could promote messages to the general population; one interviewee pointed out that famous Saudi women should be selected to deliver public health messages aimed at Saudi women, and with respect to children, cartoon characters and TV personalities in famous children's shows should be spokespeople for the campaign. It was assumed that the spokespeople for children's health would have messages that would be aimed at the parent when used on social media.

An important point was made by many of the interviewees, and that is that the social media campaign should just be a component of a larger public health campaign that has more traditional elements, such as traditional media and public events. The idea would be that the spokespeople selected to promote the public health messages at the events and in traditional media would also be serving as the face of the campaign on social media. Here are some of the points made:

For example ... there is a famous character, and he is a real person, by the way. I was in Canada, and I know this person has real

programs on TV [aimed at children]. So we could use someone like him as an example of how to tell our children exercise is actually required, and you have to move around and don't stand in front of the screen all the time. There should be breaks and so on.

Influencers in the community – they leave a big impact.

Influencers such as TV stars, and it [the campaign] should be on TV and in newspapers and also in social media, because it would make more of an impact.

Regardless of these recommendations, two nurses pointed out a what might be an inevitable truth, which is that the face of the social media portion of a public health campaign will likely be the actual members of the MoH special team assigned to interact with the public on social media, since they will be the ones actually talking to the public.

I would suggest a famous comedian, but I think people would interact on social media like Facebook or Twitter if we [at the MoH] were active. The questions have to be answered correctly and quickly, or else we will invalidate the effectiveness and the importance of our online campaign.

It should be on TV, in newspapers, and in social media, but it will make more impact if the program is championed by the MoH special team.

Finally, several participants highlighted the role of leveraging patient stories in the social media campaign, for both adults and children.

The face [of the campaign] should target the younger generation because they are the future. For example, children's success stories about how they can live easily with diabetes, or cartoon characters [with the same message]. Because people will emotionally react more with happy-ending stories. Whoever is selected to champion the program should be part of the MOH team or clinic staff and paid part-time.

In short, it seems that a more permanent implementation of a social media campaign as a component of a larger public health campaign would be eminently feasible within the existing MoH routine policies and procedures, and that there are many proven options for the types of spokespeople who can be invited to participate in campaigns, both traditionally and on social media.

4.3.3 Factors in the Broader Community Environment

Finally, participants were asked how realistic they thought the DNWD Twitter campaign was, and how realistic they thought it would be to expect community participation in such an online social media campaign. Only one participant – the NDPCP government official from Al Ahsa - found the DNWD Twitter campaign unrealistic. He made this point:

We actually tried many efforts over our 5-year campaign and did not find a simple solution from the beginning except just to tell people that diabetes is the main reason for blindness, dialysis and amputation of limbs. Evidence shows you can delay diabetes, and studies about how to achieve community participation has shown that you need rewards offered to the community from business and other community partners to make people more active with the campaign.

The physician is referring to a typical strategy that is used in Saudi Arabia to encourage community participation in a public health campaign. While these campaigns are organized and funded by the government, they recruit community partners (businesses, charities, and other organizations) to put up prizes for competitions in the community surrounding the campaign (such as a tracking kilometers walked). The physician's point, that these activities are highly effort-intensive and have not yielded extensive results, is well-taken, as he points out correctly that many years of public health research has shown that it is difficult to increase health knowledge and behaviors in a population, even with the most evidence-based approaches.

On the other hand, the other participants saw Twitter and other social media as serving as a complementary messaging channel to the ones described by the physician. As an adjunct to traditional public health campaigns, a social media campaign was seen as very realistic for many reasons: it is cheap to implement, it encourages engagement with the public, and it provides information from a known and trusted source directly. A physician from Hafr Albatin actually pointed out that it might be more realistic that originally thought:

It could be surprisingly realistic, because people like an easy way to get information they trust, and with people responding, the engagement will be fast. The community will participate if it's at least from a trusted source like our MoH social media accounts.

Another participant pointed out that if the community becomes accustomed to having a social media component to every public health campaign, they will start to get used to it and expect it. They will start using social media tools to interact with the campaign quickly, even if they attend an event in-person or see media on television or online.

Although it is not known now, because social media components are not standard in every MoH campaign, it was speculated by the participants that the social media component would promote direct interaction between the public and the MoH team assigned. The social media component cannot replace the other components of a traditional public health campaign, but could effectively work together with them to improve service to the community. As a physician at Al Ahsa pointed out:

[Social media] has an effective role, but I think visiting clinics, and face-to-face communication are more effective in simulating real problems ... but the #Do Not Wait for Diabetes awareness campaign [on Twitter] surprised me in unexpected ways. The people were asking about details to know diabetes better, and the way they interacted was great.

In summary, the interviewees by and large saw the DNWD Twitter Campaign and others like it as realistic and that they would be successful at stimulating engagement and interaction with the community. However, it is important to realize that the participants in general envisioned the social media portion as a component that should be added to traditional campaigns, and should be part of the consideration when contemplating, designing, and budgeting for public health campaigns at the national level.

5.0 Discussion

This novel project included a Twitter-based public health campaign intervention, along with three substudies surrounding the campaign to better understand its impact in terms of satisfaction and engagement of its audience, and the views of its stakeholders. Although studies have been done in the space of public health and social media, this is the first comprehensive study done that has collected data from multiple stakeholder groups to provide an overarching perspective with respect to the impact of the social media component on stakeholders participating in the campaign.

The project had four objectives. Objective 1 was to develop a targeted social media model for the DNWD Campaign on Twitter. This was achieved by working together with a group of experts at the NDPCP, setting up formalized processes, and evaluating the impact of the campaign on its participants as it went along. Both qualitative and quantitative results from Twitter and the campaign showed evidence that the social media model developed for this objective was successful at impacting the participants in the campaign.

Objective 2 was to conduct a time series analysis to see if there was an ecological association between the period of time of the social media campaign and an increase in frequency of T2D screenings at two diabetes centers. Unfortunately, Objective 2 was not fully met, because data from the MoH for the two clinics under study were not stored in the format that would have provided a clear analysis. Although data were available, because of the time frame of the data, it was not easy to estimate the frequencies of screening before and after the Twitter campaign was started, and there was no way to estimate a potential ecological association.

Objective 3 was to determine the user engagement and satisfaction with the DNWD Campaign on Twitter. To answer Objective 3, a successful user survey was conducted, and it was found that 95% of respondents reported getting screened for T2D, and of those, 87% said they were motivated by the tweets from the campaign. Survey respondents reported engaging with the tweets, with 81% reporting retweeting at least one DNWD tweet. Respondents also expressed satisfaction with the tweets, with 98% agreeing that the tweets provided them information they did not know. These results suggest that the participants of the campaign were positively impacted by the campaign through their engagement and satisfaction with the tweets.

The intention of Objective 4 was to explore the sustainability of the DNWD Twitter Campaign from the point-of-view of stakeholders working at the two clinics under study. Results from Objective 4 show that stakeholders interviewed responded positively to the DNWD Twitter Campaign, felt that it was consistent and well-aligned with MoH goals and values, and felt that a social media component should be budgeted for and built into future public health campaigns. This suggests the stakeholders interviewed felt that the DNWD Twitter Campaign had made a positive impact on the overall MoH-led health education effort associated with World Diabetes Day.

The findings from these three substudies are consistent with the existing literature about public health campaigns in general, in that many of the people who participated in the screening may not have been high risk for T2D (32,33). However, this campaign seems to have been more effective in terms of inspiring action and interaction in its participants compared to traditional public health campaigns, especially when compared to the reports provided as part of the interviews in Substudy 3.

It appears that social media has a very broad reach, much broader than traditional methods, and can also create a direct link between public health professionals and the population, so questions can be answered. In that way, it is an ideal setting for health education and dissemination. On the other hand, social media is very limiting compared to other public health campaign approaches, in that there is a large amount of value that is placed on intimate, in-person interaction that cannot take place on social media. Licensed clinicians providing in-person health education can never be replaced by social media. However, it is clear that social media campaigns promoting health information and healthy actions that work in concert with traditional campaigns can act as a catalyst to the traditional campaigns, thus improving their overall value.

It is hard to compare this study with other studies because of a lack of comparable studies. Other social media studies in medicine have not focused on the goal of providing a public health campaign (53,59,111). Studies about Twitter specifically in the public health field have focused on such a diversity of approaches and outcomes that those projects are difficult to compare to this one. For example, one study did a content analysis of tweets that were sent from several diabetes-focused health organizations; this differs in study design from this study in that in the study described, tweets were prospectively designed to elicit interaction (78). Another study only focused on reactions to tweets in an effort to determine the optimal content to elicit interaction (54). Yet, another reflects on engagements in Twitter and theorizes a framework through which to think about this (52). No comprehensive studies were found where the researcher planned a public health intervention campaign, and collected data

about both the process and the outcomes of the campaign like was done in this study. Therefore, with only “piecemeal” findings in the literature, it is hard to compare this comprehensive program with any other particular project or study.

The HBM was the driving theory behind the structure of the campaign. The goal of the campaign was to increase the likelihood of KSA residents engaging in the behavior of obtaining a T2D screening. Through the lens of the HBM, the DNWD Twitter Campaign was designed to increase the likelihood of screening behavior. In the survey respondents, it appears through their satisfaction and engagement with the tweets and through their report of screening behavior that the campaign met its goal, at least in those who were directly exposed to it. There is some evidence from actual response to tweets from the campaign that this health information increased the “perceived threat” of having diabetes, and this may have inspired members of the Twitter audience to get screened. It is also possible that promoting the health information on the NDPCP Twitter account served as a “cue to action” to get screened. In addition, when tweet messages were formed, they considerations were made to promote messages that reduced the perception of barriers to screening, increased the perceived benefits of screening. A theme that ran through many messages was that if one actually is positive for T2D, one has the opportunity to manage it and lead a healthy, satisfying life if they are willing to get screened, know their status, and engage in their health.

Some attention here should be given to the concept of “causal inference”. The project that was completed for this dissertation was the implementation of a public health program and a subsequent program evaluation. This is not scientific research, where a sample is strategically drawn from a population, and inferences made about the

sample are then extrapolated to the population. Instead, this is public health research, where the purpose of data collection is to estimate the efficacy of the public health program, and to troubleshoot how the program may be sustained or improved. Given this, the way the results have been interpreted in this study in terms of “impact” have been focused on the individual impact experienced by participants. In Substudy 2, respondents reported being impacted by the campaign by receiving new information and by engaging with tweets in the campaign. In Substudy 3, respondents reported being impacted indirectly by the campaign as they conducted other business associated with T2D health promotion. These impacts should be seen as descriptive measures that relate to evaluating this public health campaign, and should not be construed as attempts to assign causal inference from a sample to a population.

This study has both strengths and limitations. A strength of this study is that the social media campaign tested was evidence-based and guided by highly-experienced public health professionals. Further, the impact of the campaign was evaluated in a number of different ways in order to provide multiple perspectives on the results of this novel approach. Another strength of this study is that it was narrowly targeted to encourage a particular health behavior in a specific population so that actionable results could be developed. Unfortunately, this also serves as a limitation, because it is not clear exactly what the results would be if the health behavior, population, type of social media, or other variables about the campaign were changed. Further, there may have been other ways to evaluate this campaign, but only a few were chosen and presented in this report. All three substudies could also suffer from different kinds of bias. The

survey in Substudy 2 could have been biased towards more healthy individuals, and Substudy 3 could have been biased toward more engaged workers.

In conclusion, this project demonstrated that social media can be used for a public health component of a diabetes awareness public health campaign that can be effective at engaging the population in public health discussions, consuming public health information, and motivating healthy behaviors. Future projects can adopt the policies and procedures developed in this project to study other applications of social media aimed at other issues and populations for public health campaigns.

6.0 Impact

The results of this study can have both regional and international impact. In terms of regional impact, the Saudi MoH can immediately implement the findings from this report. They may choose to enact policy to add a social media campaign component to their future public health awareness campaigns. This would hopefully further the reach of the health awareness education aspects of the campaign.

In terms of international impact, this project represents the first comprehensive report about a social media component of a larger government-sponsored health awareness about T2D campaign. Therefore, it represents a prototype that public health practitioners can use as a guide for implementing their own campaigns. The literature reviewed revealed that public health professionals were excited about the prospects of using social media in public health campaigns, but methods of doing this had not been established. This prototype approach should hopefully unlock the door to other prototype approaches based on this one that can be designed for regional populations all over the world.

7.0 References

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Appendix A: Search Strategy

For both the OVID searches, the strategy for the “diabetes and social media search” would proceed this way:

1. All of the results for the diabetes MeSH headings search would be combined into one set of search results using OR.
2. All of the results for the social media MeSH heading search would be saved into one set of search results.
3. These two sets of search results would be combined with AND.

For the SCOPUS “diabetes and social media” search:

1. All of the results from the diabetes search terms would be saved in one set of search results.
2. All of the results from the social media search term would be saved in one set of search results.
3. These two sets of search results would be combined with AND.

The strategy for the “diabetes and health promotion” search, in both OVID searches, would proceed this way:

1. All of the results for the diabetes MeSH headings search would be combined into one set of search results using OR.
2. All of the results from the Health Promotion and Mass Screening MeSH headings search would be combined into one set of search results using AND.
3. These two sets of search results would be combined with AND.

The SCOPUS search strategy for “diabetes and health promotion” would proceed this way:

1. All of the results from the diabetes search terms would be saved in one set of search results.
2. A set of results from searching for the term “health promotion” would be saved separately from a set of results from searching for the term “mass screening” or “screening”, and these two sets combined with AND.
3. The first and second set would be combined with AND.

Do Not Wait for Diabetes (DNWD)

Campaign Twitter Manual

Updated November 2017

Executive Summary

The purpose of this manual is to guide the operation of the Do Not Wait for Diabetes (DNWD) Campaign Twitter account. First, it describes policies and procedures around developing tweets. This section focuses on message themes, content, and tweet characteristics. Next, this manual describes the process of delivering the Twitter messages.

The next section provides guidelines for engagement, and provides recommendations for selecting accounts to follow, acknowledging new followers, and retweeting. Appendices are present at the end for further guidance.

Overview

This manual is a guide for those involved in the DNWD Twitter Campaign sponsored by the National Diabetes Prevention and Control Program (NDPCP) of the Ministry of Health (MoH) of the Kingdom of Saudi Arabia (KSA).

The DNWD Campaign of the NDPCP was already in progress when the Twitter campaign started. This campaign is to promote knowledge of diabetes among the people of KSA, mainly to reduce the level of undiagnosed diabetics in the population.

While the overall DNWD campaign is aimed at diabetes education and awareness, the DNWD Twitter Campaign was specifically focused on encouraging undiagnosed diabetics to get diagnosed and be under care.

This project focuses on taking over the NDPCP's Twitter account (@NDPCP_Moh), and using it to spread the word to KSA residents and nationals about the importance of knowing one's diabetes status, and being diagnosed if one is positive. It will be used to promote high risk individuals in accessing MoH healthcare facilities to undergo diabetes screening and learn their status. The potential public health impact of the DNWD Twitter Campaign are being studied by Dr. Hossam Alakhrass, who is in the doctoral program at Imperial College in London and is also partnering with the NDPCP and MoH on this project.

This manual was developed to guide the individuals who will be using the DNWD Twitter account to spread the word about getting diagnosed with diabetes. It provides explanations of approaches to be used which are evidence-based, and descriptions of procedures. This manual as continually updated as the program developed.

Development and Approval of Messages

Development of Message Text

First, messages were developed in a Microsoft Word document. Only Arabic versions of tweets were included because only Arabic versions were tweeted.

Development of Message Images

Previous research has shown that whenever possible, a tweet should include an image to increase engagement. The NDPCP has a graphics design department that has an image bank of images on file; any of these could be used in the tweets being developed. In addition, Dr. Alakhrass purchased commercial images and was able to develop his own unique images. These were given to the graphics design department for final editing before being used in a tweet.

Example image – from NDPCP Graphic Design Bank



www.moh.gov.sa | 937 | SaudiMOH | MOHPortal | SaudiMOH | Saudi_Moh

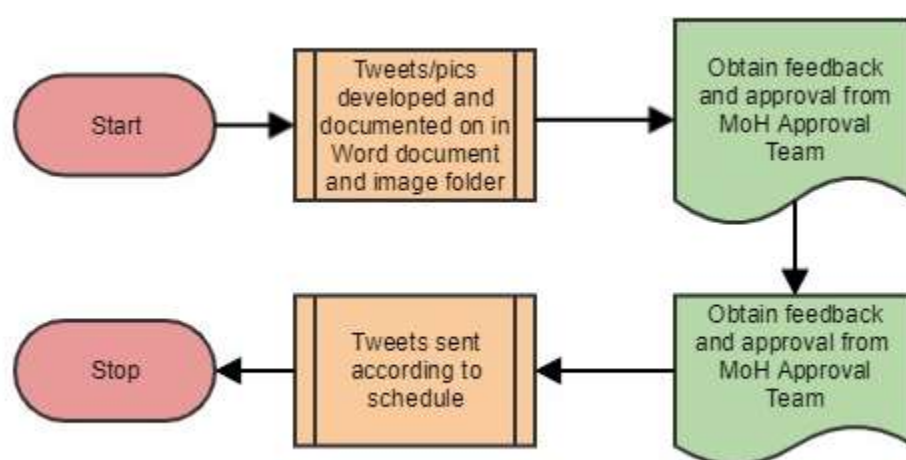
Example Image – Developed by Dr. Alakhrass



Tweet Approval Process

When tweet text was developed, and images were either selected or developed, the text of the tweets were not married up with specific images. Rather, the text was assembled in a Word document, and the associated images anticipated to be used were saved in a folder. Then, the tweets were pre-approved using the process shown in Figure 1.

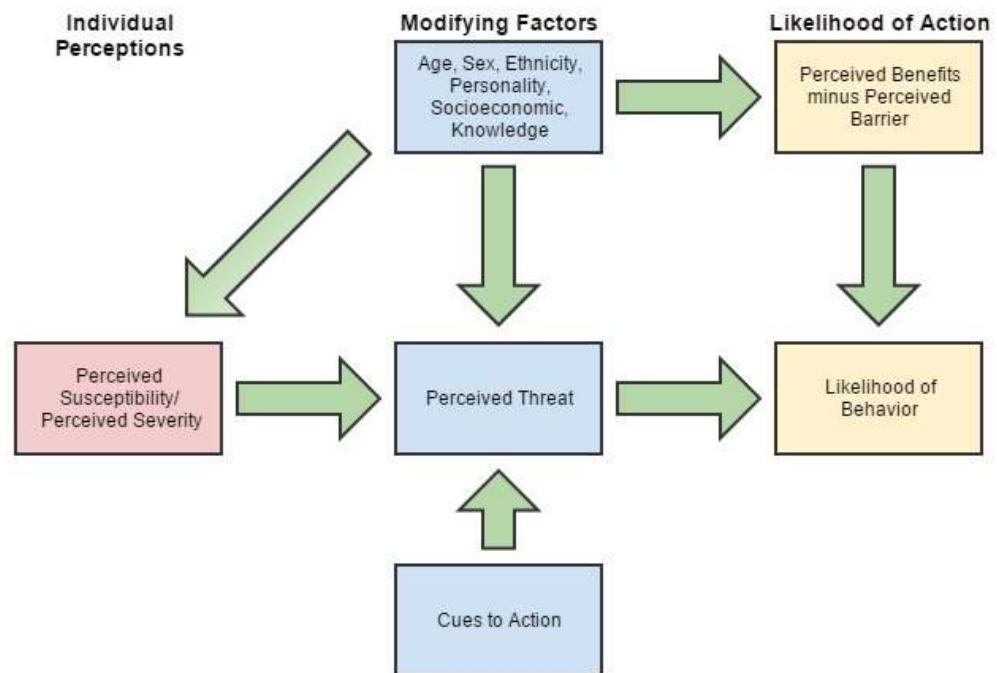
Figure 1. Tweet Approval Process



As shown in Figure 1, an MoH Approval Team was assembled consisting of the Director of the NDPCP, and a diabetologist and an Arabic translator who work at the NDPCP and have expertise in diabetes. This team reviewed the Word document and images and provided feedback to Dr. Alakhrass so he could revise and tweets or images before sending them out on the NDPCP Twitter account. The diabetologist provided especially useful feedback to improve tweet clarity and quality.

Message Themes

Originally, message themes were to be designed around the health belief model.



Source: Stretcher, V., & Rosenstock, L. M. (1997). The Health Belief Model. In Glanz K., Lewis F.M., & Rimer B.K., (Eds). *Health Behavior and Health Education: Theory, Research, and Practice*. San Francisco: Jossey-Bass.

Health Belief Model was used as a guide. Themes to include in tweets are listed under each category of the model.

Individual Perceptions

- Explaining risk factors for diabetes – to increase knowledge of perceived susceptibility
- Explaining complications of diabetes – to increase perceived severity

Modifying Factors

- Explaining how prevalent diabetes is in Saudi Arabia – to increase perception of threat
- Explaining details of how to undergo diabetes screening – to increase response to cues to action (undergoing screening)

Likelihood of Action

- Explaining benefits of diabetes screening – to increase perception of benefits
- Explaining how to overcome barriers to screening – to decrease the perception of the level of barriers to screening

Message Content

Messages for tweets were developed for the themes above. Examples are listed below:

Individual Perceptions

Below is an example of a real tweet that was sent from the NDPCP account focusing on adjusting individual perception of risk.



@NDPCP_MOH: Diabetes affects the nerves and sensation in your feet. It impacts the medium and small blood vessels, and your ligaments. It can cause foot deformity and a decrease of immunity, and you may get an infection that will not go away.

Modifying Factors

Below is an example of a real tweet explaining that if a woman is pregnant and has diabetes, this can be a modifying factor that should inspire her to be under a physician's care.



@NDPCP_MOH: If a woman has gestational diabetes, the infant is at high risk for the complications of are obesity, hypoglycemia, jaundice, RDS, diabetes type II when they are older, and death.

Likelihood of Action

The below tweet is an example of directly attempting to establish a cue to action.



@NDPCP_MOH: Diabetes is a main cause of blindness, kidney failure, heart attacks, brain death, and amputation. Go to the nearest primary healthcare center for a diabetes screening test.

Tweet Characteristics

Including Links

Links may be included in messages. The links that will be included fall under the following categories:

- Links to web pages that say where MoH diabetes centers are, and otherwise provide directions and ways to access them for screening
- Links to information about what happens when getting screened
- Links to information about symptoms of diabetes, with the idea that those experiencing symptoms should go for a screening
- Links to information about risk factors for diabetes, with the idea that those with risk factors should get screened
- Links to organizations and web pages with information about diabetes

Including Hashtags

DNWD Campaign Official Hashtag

The DNWD Campaign on Twitter has an official hashtag, which is

[#لا تنتظر_السكري](#) which translates to #DoNotWaitForDiabetes. This was used with each tweet, and its use was encouraged to other Twitter users.

Other Hashtags Used

Hashtags are used by Twitter users to find content that is often outside of their feed. This makes including hashtags a powerful way to get exposure to other Twitter accounts. The following is a guide to including hashtags on DNWD Campaign tweets:

- Each hashtag should in some way relate to the content of the tweet. This includes the information from a link or an image included in the tweet.

- Each hashtag should be chosen from a hashtag database of trending hashtags related to health or diabetes to make it the most visible
- Hashtags were sometimes used for geographic targeting (e.g., to target the Hafr Albatin area because there is a health event)
- Hashtags should only be included in messages if there is room.

Guidance for choosing hashtags is in Appendix B.

Delivery of Messages

Messages will have been approved before being sent. While individuals assigned to help with the campaign will be encouraged to improvise messages when interacting with accounts, the main messages for the accounts will have been reviewed by the MOH Approval Team. Individuals working the accounts are to use these tweets.

The preformed messages may include links and images, but will not include hashtags. It will be the responsibility of whoever is sending the tweet to add hashtags at the time of scheduling the tweet if space is available. Please see Appendix B for guidance on adding trending hashtags at time of scheduling the tweet.

Engagement Guidelines

These guidelines set forth how to deal with engagement by other accounts with the DNWD Account. It covers retweeting messages, acknowledging engaging users, and answering user questions. Detailed engagement guidelines are also in Appendix B.

Following Accounts

The accounts that the NDPCP Twitter account is following are fixed; new accounts are not supposed to be followed. Therefore, Dr. Alakhrass did not follow any accounts, but used like and retweet functions to provide positive feedback to tweets from other accounts.

Retweeting

Each time the person who is scheduling tweets does work on the account, the person should review recent tweets in the Twitter feed.

- All retweets should try to focus on the topic of diabetes. If not directly related to diabetes, the retweets should at least be related to health.
- Tweets from MoH or other Saudi governmental agencies should be retweeted if possible.
- Other tweets can be selected from reputable sources for retweeting. Preferred sources include schools, colleges, and non-governmental organizations.
- Retweets may include those announcing health-related events from reputable sources.
- Comments may be added to retweets.

Conclusion

The DNWD Twitter Campaign was managed by Dr. Alakhrass from November 15, 2017 through July 31, 2018. During this time, Dr. Alakhrass was successful and increasing the number of followers from about 6,000 to almost 9,000. In addition, the profile of the NDPCP Twitter account was raised because many more users were interacting with the account, and mentioning the account in their tweets. Overall, the process of developing, approving, and sending tweets worked optimally, and this campaign offered the NDPCP an opportunity to do grass roots public health with individuals in the KSA directly over Twitter.

Appendix B. Hashtag Guidance

To increase exposure of tweets, hashtags should not be prepared beforehand. Instead, when the tweet is to be sent, the person sending the tweet should include as many currently trending hashtags in Saudi Arabia. Luckily, these are mostly religious so they can be included without much difficulty.

Here are places that can be looked at for trending hashtags:

1. When logged into Twitter, on the home page, there are recommended trending tags given the account tweets and followers that can be used.
2. This site allows the user to navigate a world map and see what is trending in every country: <https://www.trendsmap.com/>

Appendix B. Engagement Guide

Direct Twitter Etiquette/Guidance

If one of the accounts the NDPCP is following (or an otherwise official account) tweets something great on Twitter, retweet it.

1. Use the retweet function – but notice you can edit the tweet and add info yourself.
2. Verify that the account is an official account and the message is consistent with the NDPCP
3. You can add notes (e.g., agreeing with the tweet, encouraging users to attend an event in the tweet, etc.)

If users are interacting and engaging while mentioning the NDPCP account, thank them

1. This can be done on an ad hoc basis – whenever a good conversation is going on
2. It can be done on Twitter or to specific accounts through direct messaging

What to do if users ask the NDPCP account a clinical question

1. If user tweets an easy, factual question (e.g., what is the phone number to the clinic?), then the NDPCP account holder can answer immediately.
2. If the user tweets a clinical question that might be difficult to answer, before answering, the NDPCP account holder should consult with the MOH Approval Team (along with others at MOH depending upon their expertise) before providing an official response to the tweet.

Appendix C: Exemption Letter from Saudi Arabia Ministry of Health

<p>Kingdom of Saudi Arabia Ministry of Health King Fahad Medical City (162)</p>	 <p>مدينة الملك فهد الطبية King Fahad Medical City</p>	<p>المملكة العربية السعودية وزارة الصحة مدينة الملك فهد الطبية (١٦٢)</p>
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IRB Registration Number with KACST, KSA:	H-01-R-012
IRB Registration Number with OHRP/NIH, USA:	IRB00010471
Approval Number Federal Wide Assurance NPH, USA:	PWAD0018774



March 27, 2018
IRB Log Number: 18-1538
Department: External
Category of Approval: EXEMPT

Dear Hossam Alakhress,

I am pleased to inform you that your submission dated March 25, 2018 for the study titled **'Impact of Health-Related Twitter Messages on Rates of Type 2 Diabetes Screening in the Saudi Arabian Population'** was reviewed and was approved according to ICH GCP guidelines. Please note that this approval is from the research ethics perspective only. You will still need to get permission from the head of department or unit in KFMC or an external institution to commence data collection.

We wish you well as you proceed with the study and request you to keep the IRB informed of the progress on a regular basis, using the IRB log number shown above.

Please be advised that regulations require that you submit a progress report on your research every 6 months. You are also required to submit any manuscript resulting from this research for approval by IRB before submission to journals for publication.

As a researcher you are required to have current and valid certification on protection human research subjects that can be obtained by taking a short online course at the US NIH site or the Saudi NCBE site followed by a multiple choice test. Please submit your current and valid certificate for our records. Failure to submit this certificate shall a reason for suspension of your research project.

If you have any further questions feel free to contact me.

Sincerely yours,



Prof. Omar H. Kasule
Chairman, Institutional Review Board (IRB)
King Fahad Medical City, Riyadh, KSA
Tel: + 966 1 288 9999 Ext. 26913
E-mail: okasule@kfmc.med.sa



Appendix D: Twitter User Survey

National Diabetes Prevention and Control Program Twitter Survey

Thank you for taking the time to click on the link you received in Twitter and considering completing this survey. You have been brought to this page because you clicked on a link in a tweet sent by the Saudi Arabian Ministry of Health's (MOH's) National Diabetes Prevention and Control Program (NDPCP)'s Twitter account as part of the "Do Not Wait for Diabetes" public health campaign.

This survey is being conducted by Dr. Hossam Alakhrass as part of his doctoral study at Imperial College London. This survey does not collect any identifying data, so respondents are completely anonymous.

The following questions ask about your perceptions of the "Do Not Wait for Diabetes" Campaign on Twitter in terms of the engagement and satisfaction with the tweets, and how much you learned about diabetes from the tweets. The survey will take 5-10 minutes to complete.

By clicking "next" you are opting to complete the survey. If at any time during the survey you choose not to participate, simply close the survey window. If you do not want to participate in this survey, please close the survey window now.

[NEXT BUTTON]

Qualifying Questions

How well are you able to understand written Arabic?

1. Very well
2. Not very well **[END SURVEY]**
3. I do not understand written Arabic **[END SURVEY]**

Is at least one of your Twitter accounts currently following the NDPCP Twitter account?

1. Yes
2. No **[END SURVEY]**

How many tweets from the “Do Not Wait for Diabetes” Twitter Campaign do you remember reading? (choose one answer)

1. None **[END SURVEY]**
2. One
3. Two to five
4. Six to ten
5. More than 10

Do you currently live in Saudi Arabia?

1. Yes
2. No **[END SURVEY]**

Engagement Questions

How many times have you searched Twitter for the official “Do Not Wait for Diabetes” campaign hashtag, #donotwaitfordiabetes? (choose one answer)

1. 0 times
2. 1 time
3. 2 or more times
4. Don't remember

How many times have you mentioned the official NDPCP Twitter account,

@NDPCP_MOH, in a tweet? (choose one answer)

1. 0 times
2. 1 time
3. 2 or more times
4. Don't remember

Did you share any "Do Not Wait for Diabetes" campaign tweets with any others?

(choose as many answers as apply)

1. Yes, I *retweeted* at least one "Do Not Wait for Diabetes" campaign tweet to my followers.
2. Yes, I told at least *one member of my family* about the information in at least one "Do Not Wait for Diabetes" campaign tweet.
3. Yes, I told at least *one friend, coworker or other nonrelative* about the information in at least one "Do Not Wait for Diabetes" campaign tweet.
4. No, I did not share any "Do Not Wait for Diabetes" campaign tweets

Satisfaction questions

Please rate how much you agree with the following statements where 5 is strongly agree, 4 is somewhat agree, 3 is neither agree nor disagree, 2 is somewhat disagree, and 1 is strongly disagree.

1. The tweets provided information about Type II diabetes that I did not know.
2. The tweets provided information about Type II diabetes that I can share with my family.
3. The tweets provided useful information about what to do if a person suspects she or he has Type II diabetes.
4. I prefer tweets that provide me education on diabetes.
5. I prefer tweets that provide me general information on diabetes.
6. I prefer tweets that talk about the risk factors and symptoms of diabetes.
7. I prefer tweets that encourage me to get diagnosed.

Please rate how much you agree with the following statements where 5 is strongly agree, 4 is somewhat agree, 3 is neither agree nor disagree, 2 is somewhat disagree, and 1 is strongly disagree.

1. The tweets were too personal for my liking.
2. The tweets did not motivate me to seek Type II diabetes screening.
3. The tweets made me think about ways to reduce my risk factors for Type II diabetes.

Please rate how much you agree with the following statements where 5 is strongly agree, 4 is somewhat agree, 3 is neither agree nor disagree, 2 is somewhat disagree, and 1 is strongly disagree.

1. The tweets were pleasant for me to look at and read.
2. The tweets were interesting.
3. The tweets did not provide the information I was looking for.
4. They made me want to get screened for Type II diabetes

Please rate how much you agree with the following statements where 5 is strongly agree, 4 is somewhat agree, 3 is neither agree nor disagree, 2 is somewhat disagree, and 1 is strongly disagree.

(educational vs. encouragement/cue to action)

1. I prefer tweets that provide me general information on Type II diabetes.
2. I prefer tweets that provide me education on Type II diabetes on topics like symptoms, diagnosis, self-management, and treatment.
3. I prefer tweets that encourage me to get screened for Type II diabetes.

Screening

Did you get screened for Type II diabetes between November 2017 and now?

1. Yes
2. No
3. Unknown/

IF YES

What motivated you to undergo Type II diabetes screening in that timeframe? Please check all that apply.

1. I was motivated by friends and/or family
2. I was motivated by my doctor or other health care professional
3. I was motivated by tweets from the NDPCP Twitter account
4. I thought I had Type II diabetes symptoms
5. I thought I had Type II diabetes risk factors
6. I am at high risk for Type II diabetes and I want to catch it early if I get it
7. Other reason: _____

Demographic Questions

What is your age?: _____

What is your gender? (choose one answer)

1. Male
2. Female
3. Other

What is your current marital status? (choose one answer)

1. Never married
2. Married
3. Formerly married, not married now
4. Other: _____

What is your ethnicity? (choose one answer)

1. Saudi
2. Other: _____

In what area in Saudi Arabia do you live? (choose one answer)

1. Al-Riyadh
2. Makkah Al-Mokarramah
3. Al-Madinah Al-Monawarah
4. Al-Qaseem
5. Eastern Region
6. Aseer
7. Tabouk
8. Hail
9. Northern Borders
10. Jazan
11. Najran
12. Al-Baha
13. Al-Jouf

Where is the closest MOH-sponsored diabetes center where you could go to get diagnosed with Type II diabetes if you thought you had it? (choose one answer)

1. Ahsa
2. Riyadh
3. Taif
4. Jeddah
5. Makkah
6. Haft Albatin
7. Don't know

Has a doctor ever told you that you have Type II diabetes? (choose one answer)

1. Yes, diabetes
2. Yes, pre-diabetic
3. No

How often do you use Twitter? (choose one answer)

1. Less than once per week
2. Once per week
3. Two to six times per week
4. About once per day
5. More than once per day
6. Other: _____

Appendix E: Interview Questions for Substudy 3

Do Not Wait for Diabetes Account Interview Questions for Government Officials and Healthcare Providers

Thank you for agreeing to participate in this interview.

First, I will read you a program description of the Do Not Wait for Diabetes, or DNWD, Twitter Campaign. Then, I will ask you questions about the sustainability of this program.

The DNWD Twitter Campaign was designed as part of the overall DNWD Campaign sponsored by the National Diabetes Prevention and Control Program (NDPCP) of the Saudi Arabian Ministry of Health (MoH). The goal of the overall campaign is to raise awareness of diabetes. The specific goal of the DNWD Twitter Campaign was to encourage Saudi Arabian residents who are at high risk for Type II diabetes to undergo a screening at a MoH clinic for Type II diabetes. Twitter was used because it is one of the most popular social media choices in Saudi Arabia. Tweets were sent out educating individuals on the risk factors and symptoms of Type II diabetes, and directing them to undergo screening at an MoH clinic.

Project Design and Implementation Factors

What was your involvement with the design of the DNWD Twitter Campaign?

[PROBE] What role did you play in the development of the campaign?

What are your thoughts on the goal of the campaign – to encourage Saudi Arabian individuals who may have Type II diabetes but not carry a diagnosis to get screened for diabetes?

What are your thoughts in making the DNWD Twitter Campaign a permanent part of the overall DNWD Campaign? **[PROBE]** What are your thoughts about how to fund this campaign?

What is your perception of the level of effectiveness of the DNWD Twitter Campaign?

Factors Within the Organizational Setting

In your opinion, how does the DNWD Twitter Campaign fit within the MoH organization? **[PROBE]** How well does it fit with existing health promotion programs?

Who do you think should be the public face of the DNWD Twitter Campaign, and why? **[PROBE]** Who should champion the program?

Factors in the Broader Community Environment

How realistic do you think the DNWD Twitter Campaign is? **[PROBE]** How realistic do you think it is that the community will participate?