Research Article

The Impact of Financial Incentives on Behavior and Self-Management of Uncontrolled Type 2 Diabetes: Pre- and Post-Quasiexperimental Study

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Source of Support: This work was supported by the National Diabetes Prevention and Control program – Ministry of Health, Saudi Arabia. Conflict of Interest: None.

Received: Dec 13, 2020; Revision Received: Feb 25, 2021; Accepted: Apr 12, 2021

Al Kathiry DA, Al Slail F, Al-Surimi K, Abusaris R. The impact of financial incentives on behavior and self-management of uncontrolled type 2 diabetes: pre- and post-quasiexperimental study. Glob J Qual Saf Healthc. Published online. DOI: 10.36401/JQSH-20-45.

ABSTRACT

Introduction: Noncommunicable diseases are one of the main challenges that affect health worldwide and have been found to be increasing in both low- and middle-income countries compared with high-income countries. The aim of this study was to assess the impact of financial incentives and a comprehensive care program focusing on patients’ behavior and self-management of uncontrolled type 2 diabetes (glycosylated hemoglobin [HbA1c] ≥ 7), as well as modifiable risk factors for disease complications in a Saudi Arabian population.

Methods: This quasiexperimental study, using a pre- and postevaluation approach, was used to compare the level of HbA1c among patients with uncontrolled diabetes before and after the financial incentives and comprehensive care program were implemented. Financial awards were given to patients who achieved a significantly greater decrease in HbA1c levels with his/her responsible physician. The study population included 702 Saudi Arabian patients with type 2 diabetes from 14 regions and 34 primary healthcare centers in the Kingdom of Saudi Arabia. All of these patients (≥ 15 years old) with uncontrolled type 2 diabetes who attended local primary healthcare centers in Saudi Arabia for a follow-up visit from February to October 2018.

Results: The mean age, in years, of the sample was 56.14 (± SD = 9.909); slightly more than half of the patients 401 (57.1%) were females. Most of the participants 645 (91.9%) were married, and 381(54.3%) patients were housewives. Linear mixed modeling revealed that all groups showed improvements over time in the primary outcome of HbA1c levels (p = 0.009), including the secondary outcomes of body mass index and systolic and diastolic blood pressure (p = 0.04, < 0.001, 0.019 respectively). Conclusions: Patient behavior was improved, which was reflected by decreases in HbA1c, body mass index, and blood pressure levels. A comprehensive care program is recommended by healthcare providers to increase awareness among patients with diabetes to reduce other risk factors. These kinds of interventions positively motivate patients with diabetes to control their health measurements and to adopt a healthy lifestyle.

Keywords: diabetes type 2, incentives, chronic disease, uncontrolled diabetes, risk factors

INTRODUCTION

Noncommunicable diseases (NCDs) are one of the main challenges that affect health worldwide and have been found to be increasing in both low- and middle-income countries compared with high-income countries. NCDs include heart disease, stroke, cancer, diabetes mellitus (DM), and chronic lung disease. Diabetes and hypertension in particular are playing a disproportionate role in the growing public health
challenges posed by NCDs, which are currently increasing the number of deaths among young people, even when combined with other causes.

The World Health Organization (WHO) has reported that the burden of NCDs is responsible for almost 70% of all deaths worldwide, and almost 40 million people die each year. According to the Centers for Disease Control and Prevention (CDC), in 2018, around 34.2 million people of all ages in the United States had diabetes (~10.5% of the total population). Worldwide, approximately 5 million deaths were attributable to diabetes among those aged 20 to 99 years in 2017. This prevalence increased to 425 million adults in 2017 and is expected to increase by 48% (629 million) among adults by 2045.

Uncontrolled diabetes may cause crucial damage to the heart, blood vessels, eyes, kidneys, and nerves. It is strongly associated with a higher risk of atherosclerosis and coronary artery disease. Physical inactivity, overweight, smoking, and unhealthy diet are the major risk factors for type 2 diabetes. A recent study demonstrated that an increase of 1% in glycosylated hemoglobin (HbA1c) levels (or 11 mmol/mol) among people with diabetes is associated with an increase in the risk of cardiovascular disease by 26%. Increasingly, young people are now suffering from DM due to changing lifestyle behaviors and poor eating habits that increased the prevalence of obesity. The increased prevalence of these risk factors has made them an important public health problem.

More than 1.7 million people die every year due to NCDs in the Eastern Mediterranean Region. DM is an important cause of morbidity and mortality. According to the World Health Organization, DM is a serious chronic disease that happens either when the pancreas does not produce enough insulin (a hormone that regulates blood glucose), which is considered DM type 1, or DM type 2, or when the body cannot effectively use the insulin it produces.

A large study done in Saudi Arabia in 2014 on a Saudi population aged 15 years and above found a total prevalence of diabetes of 13.4%. The prevalence was 11.7% among females and even higher (14.8%) among males. The total prevalence of obesity among the Saudi population was 28.7%. In addition, the prevalence of hypertension was 17.8% for males and 12.5% for females. The result of another study indicated that diabetes is associated with obesity and hypertension, while the prevalence of hypertension is 38.9% among those with diabetes, in contrast to 11.9% among those who are not diabetic.

A cross-sectional study estimated the risk of cardiovascular disease using the Framingham risk calculator for adults aged 20 years and older in the general population. The results showed that more than half (55%) of Saudi subjects had more than two risk factors and 20% had four or more risk factors. When considering diabetes according to the coronary heart disease risk-equivalent, almost 26% of subjects were classified as being at high risk of suffering from coronary events in 10 years.

These significant prevalence numbers could be preventable by implementing wellness programs that promote diabetes control through motivating lifestyle changes and disease management. Positive knowledge, attitude, and practice play a vital role for DM patients and for any future disease development. A longitudinal study used a structured questionnaire to obtain baseline information regarding knowledge, attitude, and practice for patients with hypoglycemia. The goal was to estimate the role of diabetic education in increasing awareness about hypoglycemia and decreasing the symptoms of hypoglycemic diabetics. The appearance of hypoglycemic symptoms was also compared before and after diabetic education. The results showed a significant improvement in all variables of knowledge, attitude, and practice with diabetic education. In addition, the occurrence of hypoglycemic was significantly decreased.

Another study conducted in Saudi Arabia examined governmental primary healthcare centers and hospitals to determine the level of diabetes knowledge among patients with diabetes who were 18 years of age and older. The results showed that more than half of patients (66.1%) had average diabetes knowledge, while 29.2% had low knowledge and 4.7% had high knowledge. A significant association and greater knowledge were found in those with younger age, longer duration of diabetes, high educational levels, and positive family histories of diabetes.

The main goal of improving public health knowledge and awareness is promoting the education of health professionals regarding the management and complications of DM, its pathology, the risk factors, its prevention, and its etiology. Considerable focus on the responsibility of health professionals is required for educating patients, families, and the community on how a healthy lifestyle could reduce the risk of developing DM and the complications of those living with this chronic disease.

Several international studies have found that there is an initial association between financial incentives in disease management that lead to improvements in diabetes control and weight. Financial incentives may encourage individuals to change their behaviors. Incentives for attaining certain health goals, such as achieving target HbA1c levels or blood pressure, have been considered to have a positive impact.

To the best of our knowledge, limited studies have been published regarding a comprehensive program for health education, follow-up, frequent HbA1c monitoring, and incentives in Saudi Arabia. Thus, the primary objective of this study was to determine whether financial incentives for physicians and such care programs are effective in motivating and encouraging patients with uncontrolled diabetes to manage their...
level of HbA1c to reduce modifiable risk factors for disease complications.

METHODS

Ethical Considerations
The study was approved by the Ministry of Health Institutional Review Board (log number 18-681E). Written informed consent forms were obtained from patients before including them in the study. The information of incentives was included in the form, only patients who agreed to participate in the study were asked to provide their information. The confidentiality of personal information was a most important consideration in this research. We made sure that the collected information was protected, and electronic case report forms were saved on a password protected office computer. Participants’ rights and safety were considered.

Study Design
This quasieperimental study compared the levels of HbA1c in patients with uncontrolled diabetes before and after a comprehensive patient care program. The patients were recruited from local primary healthcare centers in Saudi Arabia in February 2018.

Study Population
A multistage sampling method was used (cluster followed by systematic sampling) to select the primary healthcare centers and patients (Fig. 1). A total of 60 primary healthcare centers from all 20 regions in Saudi Arabia were selected randomly from the statistical book of the Ministry of Health. From each center, 25 patients were recruited during their regular clinic visits. A total of 1500 patients were selected (Fig 1).

The inclusion criteria for primary healthcare centers was the availability of HbA1c devices. From those centers, the inclusion criteria for patients were Saudi individuals, at least 15 years or older, and patients with uncontrolled type 2 diabetes and HbA1c of 7 mmol/L or greater. Patients with gestational DM or other types of diabetes were excluded.

Study Intervention
Patients were told about receiving a financial incentive before being included in the study. The incentives were cash amounts of 1500 Saudi Riyals (400 USD) to patients and 2000 Saudi Riyals (534 USD) to physicians.

The patients’ blood sugar levels were measured in three visits. After each measurement, patients received health education materials (such as leaflet and brochures) from the health educators. After the third visit, financial awards were given to patients who achieved the target HbA1c level, along with the physician who regularly saw the patient.

Proof with documentation was required after finalizing the data using a copy of the patients’ files.

A multi-stage sampling method was used (cluster followed by systematic sampling). A total of 60 primary healthcare centers were selected randomly from the statistical book of the Ministry of Health. A total of 1500 patients with diabetes were selected from the family medicine clinic at a local primary healthcare center using a systematic random sampling technique. From each primary healthcare center, 25 patients were recruited during their regular visits to the clinic in all 20 regions in Saudi Arabia. A simple random method was used to select the patients and the primary healthcare centers by using a randomizer website (Fig. 1).

Data Collection
Data were collected from all primary healthcare centers that were involved in the study. The physicians were responsible for filling in forms that contained sociodemographic status, patient contact numbers, and the measurements of blood sugar and other risk factors from the three visits, such as body mass index (BMI) and blood pressure (BP). A case report form was electronically uploaded in the diabetes prevention and control program website and was sent by email. Patients were followed for 9 months starting in February 2018.

The first window of visits was from February 11 to 21, 2018. Patients were recruited and baseline information was obtained. In the second window (May 11–21, 2018), new measurements were compared with the baseline information. During that period, patients needed tight control of medications due to the month of Ramadan. The final window was from October 11 to 23, 2018. A 3-month period between visits was established to make
sure that patients were monitored for the past 3 months during this specific duration.

Microsoft Excel 2016 (v16.0) was used for data entry, coding, cleaning, and analysis.

Statistical Analysis

The data analysis was done using IBM SPSS Statistics, version 25 (SPSS, Chicago, IL). Descriptive statistics were used for categoric variables in the form of frequencies and percentages, while the mean and SD were used for continuous variables. A bivariate statistical analysis was used for different variables. Patients’ characteristics according to HbA1c levels were compared using a paired-samples t-test to determine whether there are significant differences between patient visits, and a Wilcoxon signed-rank test was performed in cases of small sample size. The 95% CIs were determined to estimate proportions and differences in means. Adjusted confounders were considered for patients on medications or fasting during the period of the second visit due to the month of Ramadan. The results were controlled for type I error at 0.05. Finally, a linear mixed model was used to examine the effect of potential confounders.

RESULTS

Participant Characteristics

Tables 1 and 2 summarize the demographic characteristics of 702 patients with type 2 diabetes from 14 regions and 34 primary healthcare centers in the Kingdom of Saudi Arabia. The mean age, in years, of the sample was 56.14 (± SD = 9.909). Slightly more than half of the patients 401 (57.1%) were females. Most of the participants 645 (91.9%) were married, and 381 (54.3%) patients were housewives.

Association Between Patient Characteristics and Study Outcomes

Table 3 shows the results of the statistical association analysis between patient characteristics and the main study outcomes of HbA1c, BMI, and BP. A total of 692 patients with type 2 diabetes were included in the analysis of HbA1c. The average difference between the first and the third visits was 0.69 (± SD = 2.80) with (p < 0.001). The mean paired difference in BMI (n = 691) between the first and third visits was 1.77 (± SD = 12.55; p < 0.001). The difference in average of systolic BP in patients (n = 693) with high BP between the first visit and third visit was 11.14 (± SD = 19.75; p < 0.001), and the difference in diastolic BP (n = 693) was 7.47 (± SD = 14.81; p < 0.001).
Table 3. Association between patients’ characteristics and study outcomes before and after program

| Variables     | HbA1c Mean ± SD | p-value | BMI Mean ± SD | p-value | BP Mean ± SD | p-value |
|---------------|-----------------|---------|---------------|---------|--------------|---------|
| All           | 692 0.69 ± 2.80 | < 0.001 | 691 1.77 ± 12.55 | < 0.001 | 693 11.14 ± 19.75 | < 0.001 |
| Females       | 399 0.53 ± 3.51 | 0.003   | 398 2.18 ± 7.77 | < 0.001 | 400 10.87 ± 21.57 | < 0.001 |
| Males         | 293 0.91 ± 1.30 | < 0.001 | 293 1.21 ± 17.01 | 0.224   | 293 11.51 ± 16.98 | 0.031   |
| Married       | 636 0.67 ± 2.90 | < 0.001 | 634 1.73 ± 12.84 | < 0.001 | 636 10.51 ± 19.35 | < 0.001 |
| Unmarried     | 56 0.83 ± 1.35  | < 0.001 | 57 2.25 ± 8.60  | 0.053   | 57 18.21 ± 22.76 | 0.030   |
| < 30 y        | 7 1.31 ± 2.47  | 0.125   | 7 10.25 ± 15.22 | 0.031   | 7 22.14 ± 16.02 | 0.031 DBP |
| 30–40 y       | 39 1.04 ± 1.25  | < 0.001 | 39 7.22 ± 13.82 | 0.002   | 39 11.46 ± 12.67 | 6 ± 10.88 |
| 40–50 y       | 105 0.85 ± 1.46 | < 0.001 | 105 3.44 ± 9.07  | < 0.001 | 105 12.77 ± 14.10 | 6.88 ± 10.81 |
| 50–60 y       | 267 0.56 ± 4.18 | 0.031   | 266 2.15 ± 6.45  | < 0.001 | 268 11.41 ± 18.20 | 6.80 ± 11.94 |
| ≥ 60 y        | 274 0.68 ± 1.28 | < 0.001 | 274 −0.23 ± 16.82 | 0.820  | 274 9.93 ± 23.56 | 8.61 ± 18.69 |

BMI, body mass index; BP, blood pressure; DBP, diastolic blood pressure; HbA1C, glycosylated hemoglobin; SBP, systolic blood pressure.

*Due to lack of normality and small-size sample, the comparison was carried out using the Wilcoxon signed-rank test.

**Linear Mixed Model**

The linear mixed model showed that all participants had glycemic improvement \((p = 0.009)\). Also, all patients showed improvement in the secondary outcomes of BMI, systolic BP, and diastolic BP (Table 4).

**DISCUSSION**

The UK Department of Health asserts that “financial incentive interventions have been suggested as one method of promoting healthy behavior change.”\(^{[21]}\) As such, this study aimed to determine whether financial incentives for physicians and comprehensive patient programs. The findings showed a significant difference in HbA1c, BMI, and BP for all patients who were involved in the program. The differences in BMI measurements showed that females reduced their weight more than males, which shows that females might be more committed. Regarding HbA1c, males and females both showed a significant difference in controlling their HbA1c levels.

Faghri et al.\(^{[23]}\) found that a financial incentives program has a positive impact on weight loss and decreasing the level of diabetes risk scores among employees at worksites. These results are consistent with our findings, and financial incentives could be more effective for both patients and employees. Misra-Hebert et al.\(^{[16]}\) assessed whether diabetes and cardiovascular risk factors among employees could be improved by financial incentives for participation in disease management and for attaining goals. Their retrospective cohort study used electronic medical records data. The analysis of employee cohorts with incentive offerings showed that fixed incentives or incentives tied to goals were not significantly associated with HbA1c, systolic BP, and low-density lipoprotein reductions compared with nonemployees. It might be that nonemployee patients have more time to follow the program. The findings showed that nonemployee patients might be motivated to reduce HbA1c, BP, and weight more than employees.\(^{[16]}\)

It could be that employees are stressed in their work environments, which affects their ability to control their diabetes and BP.

In our study, the percentage of housewife patients was higher than that of employed patients, and the reduction of most measurements was significantly different. Females and married patients were more than half of the participants, which resulted in a significant difference in controlling their measurements compared with males and unmarried people. It might be that females are keener to maintain a certain healthy lifestyle that would control their blood glucose level, BP, and weight compared with males. In contrast, in a study by Madmoli et al.\(^{[24]}\) the majority of people with diabetes were females. However, many studies showed that the percentage of diabetes among females is more than among males, while in terms of complications, males are affected more than females.\(^{[24]}\) Another study by Ramezanian et al.\(^{[25]}\) found that the “association between health outcomes and marital status is diversified by gender.” They found that among females, low risk of type 2 diabetes was associated with being widowed (hazard ratio 0.69; 0.51–0.93), while being a single male was an essential risk factor for hypertension (hazard ratio 1.41; 1.01–1.97).\(^{[25]}\)

In this study, the results showed that incentives have a positive influence among patients older than 30 years compared with the youngest patients. Surprisingly, there was no statistical difference in the measurements of HbA1c, BP, and BMI among age groups younger than 30 years. We think that the level of awareness among age groups might be different. Young people might not be able to control themselves to follow a healthy lifestyle compared with older people. The effectiveness of incentives in a study done by O’Leary et al.\(^{[26]}\) was quite similar to our results in that older patients with diabetes were more influenced to reduce and control their levels of blood sugar than middle-aged patients. They investigated financial incentives to evaluate the improvement of glycemic control among uncontrolled patients with type 2 diabetes (≥ 18 years). They demonstrated that among the patients (31–90 years old with a mean age of...
Table 4. Glycosylated hemoglobin (HbA1c) and secondary outcomes: mixed-model analysis with interactions

| Effect                        | p-value |
|-------------------------------|---------|
| HbA1c                         |         |
| Time                          | 0.009   |
| Sex                           | 0.456   |
| Marital status                | 0.476   |
| Age category                  | 0.634   |
| Time × Sex                    | 0.429   |
| Time × marital status         | 0.897   |
| Time × age category           | 0.974   |
| Sex × marital status          | 0.680   |
| Sex × age category            | 0.936   |
| Marital status × age category | 0.667   |
| Time × sex × marital status   | 0.657   |
| Time × sex × age category     | 0.732   |
| Time × marital status × age category | 0.820 |
| BMI                           |         |
| Time                          | 0.011   |
| Sex                           | 0.004   |
| Marital status                | 0.723   |
| Age category                  | < 0.001 |
| Time × sex                    | 0.375   |
| Time × marital status         | 0.015   |
| Time × age category           | 0.937   |
| Sex × marital status          | < 0.001 |
| Sex × age category            | 0.199   |
| Marital status × age category | 0.041   |
| Time × sex × marital status   | 0.683   |
| Time × sex × age category     | 0.824   |
| Time × marital status × age category | 0.940 |
| SBP                           |         |
| Time                          | < 0.001 |
| Sex                           | 0.199   |
| Marital status                | 0.568   |
| Age category                  | 0.197   |
| Time × sex                    | 0.248   |
| Time × marital status         | 0.711   |
| Time × age category           | 0.629   |
| Sex × marital status          | 0.680   |
| Sex × age category            | 0.746   |
| Marital status × age category | 0.764   |
| Time × sex × marital status   | 0.530   |
| Time × sex × age category     | 0.263   |
| Time × marital status × age category | 0.416 |
| DBP                           |         |
| Time                          | 0.019   |
| Sex                           | 0.452   |
| Marital status                | 0.837   |
| Age category                  | 0.520   |
| Time × sex                    | 0.512   |
| Time × marital status         | 0.885   |
| Time × age category           | 0.540   |
| Sex × marital status          | 0.553   |
| Sex × age category            | 0.585   |
| Marital status × age category | 0.913   |
| Time × sex × marital status   | 0.910   |
| Time × sex × age category     | 0.789   |
| Time × marital status × age category | 0.877 |

BMI: body mass index; DBP: diastolic blood pressure; SBP: systolic blood.

Bold values considered significant, p < 0.05.

61 years), those who were enrolled to receive financial incentives to control their blood sugar level significantly decreased their blood sugar levels more than patients who did not receive incentives.[24] Furthermore, a randomized controlled trial study done in a primary care and community settings, they compared the usual medical care on weight loss and glycemic outcomes with an effects of an intensive lifestyle intervention among individuals with type 2 diabetes, aged 18 to 50 years. The intervention of lifestyle was resulted a significant weight loss at 12 months and associated with diabetes reduction to over 60% of participants. These kinds of intervention lead to motivate people with diabetes in changing behavior to a healthy lifestyle.[27]

According to this study, we interviewed some of the patients and asked them a few questions regarding their experiences during their participation, and if they are willing to control HbA1c level in their lifetime. Thus, the following is based upon patient interviews:

Participant 1: “The competition [has] motivated me to control my HbA1c level, and I am happy for this change.”

Participant 2: “I tried to change my lifestyle to decrease my HbA1c level; I am still controlling my blood sugar.”

Participant 3: “I am taking my pills. But, [have not visited] the primary healthcare centers for 6 months … to check my blood sugar due to a lot of responsibilities and work. However, the competition [has] motivated me in controlling my HbA1c level.”

Participant 4: “The competition led me to control my blood sugar and I am still controlling my HbA1c level by following a healthy diet and trying to change my lifestyle. Also, I am visiting the primary healthcare center every 3 months to check my HbA1c level.”

Participant 5: “I controlled my HbA1c during the competition and I am still under control by following a healthy diet and doing exercise. Also, I am visiting the primary healthcare center every 3 months.”

Participant 6: “I was so happy when I knew that I [was] one of the best patients [because I] had a greater decrease in my HbA1c. The competition affected me in a positive way, and I am [willing to continue] to control my blood sugar.”

Strength and Limitations

We believe this study is the first of its kind to be conducted in Saudi Arabia, and related studies from the Middle East were found to be limited. However, there are limitations to this study. The main limitation is the absence of a comparison group. Furthermore, the plan was originally to recruit 1500 patients from 60 primary healthcare centers in 20 regions. However, owing to the unavailability of necessary equipment, we ended up with 702 patients from 34 primary healthcare centers in 14 regions. The limited time of observation. In addition, the data collection was time consuming due to the holidays, and data were collected in an Excel sheet instead of...
specific software, which led to data being obtained in a different format from each primary healthcare center. A larger sample size would increase the representativeness of the data for patients with diabetes in the Kingdom of Saudi Arabia. Moreover, there are a limited number of studies on evaluation programs for patients with diabetes in Saudi Arabia. Overall, our study findings are consistent with previous studies showing the effectiveness of incentives programs, especially that the program’s effectiveness is increased when involving the physicians. We are among the pioneers to do such a study in Saudi Arabia, and as such, the number of related studies that we could find are limited.

CONCLUSIONS

The aim of our study was to determine whether financial incentives for physicians and comprehensive care programs are effective in motivating patients with uncontrolled diabetes to manage their level of HbA1c and reduce modifiable risk factors with disease complications. Patient behavior was improved, which was reflected in decreases in HbA1c, BMI, and BP levels. The results showed a positive impact in controlling the patient’s health measurements. In particular, the financial incentives encouraged physicians to provide more intensive health education to the patients, which in turn raised the awareness among patients with diabetes.

The patient who was given an award after finalizing the results was interviewed to talk about her experience during the follow-up and how the program affected her behavior. The financial incentives encouraged the patient to change her behavior by taking medications and following a healthy lifestyle, and she intends to continue living her life in healthy ways.

A comprehensive care program is recommended by healthcare providers to increase the awareness among patients with diabetes to reduce risk factors. These kinds of interventions positively motivate patients with diabetes to control their health measurements and to adopt a healthy lifestyle, which will hopefully be socially contagious. Further research should be done to establish a cause and effect relationship between incentives and the level of awareness in controlling diabetes and other complications among patients with diabetes.

Acknowledgments

We thank the staff and coordinators of National Diabetes Control and Prevention Program, Ministry of Health, Kingdom of Saudi Arabia, and we gratefully acknowledge the patients who participated in this study.

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