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Assessment of the Cost-Effectiveness of Telemedicine Care for Patients with Uncontrolled type 2 Diabetes Mellitus during the COVID-19 Pandemic in Makkah Al-Mokarramah, Saudi Arabia 2022

Abdulrahman Salem Dhaifallah Altalhi[1], Hamzah Ahmed Alyamani[2], Emad Bakheet Atiah Almalki[3], Saad Mohammed khalid Albaqami[4], Mohammed khalaf Atyan Althagafi[5], Bandar NAIF Almutairi[5], Saleem Ghurmullah Alzahrani[5], Mohammed Ahmed Alzahrani[6], Saeed Safran Husseen Al-Malki[7], Faris Mohammed Alsharif[8], Faisal Abadi Almatrafi[9], Ahmad Khalaf Ahmad Almajnoni[10], Mazen Abdullah Althobaiti[11]

[1]Pediatric Specialist, Taif Children Hospital, Saudi Arabia.
[2]Pharmacy technician, Shmeisi Medical Complex, Saudi Arabia.
[3]Technician Pharmacy, Children Hospital in Taif, Saudi Arabia.
[4]Health informatics Specialist, Children's Hospital in Taif, Saudi Arabia.
[5]Health informatics technician, Children's Hospital in Taif, Saudi Arabia.
[6]Pharmacist Assistant, Children's Hospital in Taif, Saudi Arabia.
[7]Hospital Administration Senior Specialist, Children's Hospital in Taif, Saudi Arabia.
[8]Health administration specialists, The patient experience in health centers, Saudi Arabia.
[9]Health education specialist, Public Health Department of Health Affairs in Makkah Al-Mukarramah, Saudi Arabia.
[10]Lab Technician, King Abdullah Medical City, Saudi Arabia.
[11]Health Administration Specialist, Children's Hospital in Taif, Saudi Arabia.

Abstract:

Background:

Routine diabetes care changed during the COVID-19 pandemic due to precautionary measures such as lockdowns, cancellation of in-person visits, and patients' fear of being infected when attending clinics. Because of the pandemic, virtual clinics were implemented to provide diabetes care. However, much of the literature published focuses on the effects of COVID-19 in hospitalized patients, with few publications providing information and advice to those caring for people with diabetes in the primary care setting. Therefore, we conducted this study to assess of the Cost-effectiveness of telemedicine care for patients with uncontrolled type 2 diabetes mellitus during the COVID-19 pandemic (DM). While telemedicine has several advantages, such as accessibility and cost-effectiveness, its diagnostic reliability should be further investigated. The Saudi Vision (2030) has drawn up a roadmap to invest in digital healthcare during the coming decade. **Aim of the study**: To assessment of the Cost-effectiveness of telemedicine care for patients with uncontrolled type 2 diabetes mellitus during the COVID-19 pandemic in Makkah Al-Mokarramah, Saudi Arabia 2022.

Method: cross sectional descriptive study conducted about telemedicine care intervention, the study consisted namely a telemedicine care model and a traditional care model. Our total participants were (107) patients with type 2 DM attending a virtual integrated care clinic at a

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chronic Illness center in a family and community medicine department in in Makkah Al-Mokarramah, Saudi Arabia 2022 during the COVID-19 pandemic, the clinical effectiveness (i.e. reduction in HbA1c) and the total cost were determined, and the incremental cost-effectiveness.

Results: the Sources of information about telemedicine care the majority of participant from Mass media were(31.8%), while Medical education in health centres and hospitals were (20.6%) , regarding the The Comorbidities of type 2 diabetes the majority of participant Hypertension were(26.2%), followed by Cardiovascular disease were (19.0%) while Chronic kidney disease were (18.7%).

Conclusion: Previous research's found the simplicity of our Diabetes Telemedicine Clinic protocol and the high satisfaction reported by patients and HCPs make it a suitable model to be adopted by clinics, especially during pandemics or disasters in resource-limited settings.

Keywords: Assessment, Cost-effectiveness, telemedicine care, patients, uncontrolled type 2 diabetes mellitus, COVID-19 pandemic.

Introduction

A global pandemic has been declared by the World Health Organization after cases of coronavirus disease 2019 (COVID-19) were confirmed throughout the world.[1] To mitigate the spread of the virus, many countries implemented a shelter-in-place order and suspension of operations in nonessential businesses.[2-3] Routine clinic appointments, including those for patients with diabetes, were cancelled with a short notice, and due to the lack of well-established telemedicine systems in many countries, a large number of patients with diabetes quickly found themselves with little to no medical support during this pandemic.[4-5]. The coronavirus 2020 (COVID-19) pandemic has severely disrupted healthcare services throughout the world. The redistribution of healthcare resources to COVID-19 care and severe lockdown restrictions made healthcare access difficult for non-COVID-19 conditions, especially for patients suffering from chronic diseases that require periodic assessment and changes in treatment plans. The medical fraternity quickly adopted alternative models of delivery of medical care for patients suffering from non-COVID-19 chronic conditions [6]. Of the several digital approaches, telemedicine and smartphone applications and instant messaging services are being commonly employed for communication between medical teams and patients [7]. One such communication tool, the telemedicine and smartphone app WhatsApp, allows users to send instant messages, photos, videos, and voice messages. It can also be used to share medical records and make voice or video calls using a mobile internet connection. [8]

Besides, the possibility to create protected groups, the so-called WhatsApp groups make WhatsApp useful for cooperative teleconsultation [9]. Telemedicine care has thus emerged as the primary telemedicine tool for virtual care during the ongoing pandemic [10-11]

Many healthcare workers had to self-isolate after getting in contact or infected with COVID-19, which led to shortages in medical staff and undermined the quality of healthcare [12]. These factors together reduced the capacity of medical practice and restricted people's access to healthcare [13]. Saudi Arabia was among the most affected countries by the

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COVID-19 pandemic in the Eastern Mediterranean Region, with a total of 537,374 confirmed patients and 8388 related deaths by 14 August 2021 [14]. As a consequence, the Saudi government took decisive measures to prevent the spread of COVID-19, such as imposing lockdown, enforcing social distancing measures, suspending public transportation, schools, and universities, preventing religious mass gatherings, and tracking travelers with possible COVID-19 infections.[15] Moreover, it worked on improving the capacity of early detection and management of COVID-19 cases via preparing several primary healthcare centers with personnel and equipment to receive people with COVID-19 symptoms and enhancing the preventive capacity by providing the COVID-19 vaccine on a wide scale. [16] These regulations made face-to-face medical consultation even harder. Like most countries worldwide, the increasing need for healthcare in Saudi Arabia during the COVID-19 pandemic was faced with a diminished capacity of medical practice and limited access to healthcare [17-18]

Before the pandemic, many studies indicated the clinical effectiveness of telemedicine in diabetes care, including significant and clinically relevant reductions in HbA1c. [19–20] . However, only limited literature is currently available on the cost-effectiveness of telemedicine for diabetes care.[21-22] It is currently believed that telehealth could decrease costs on the health system, particularly when telehealth services prevent health system-funded travel, leading to reductions in secondary care,[23]and when telehealth mitigates the need for costly specialist interventions by providing quality care in an efficient manner, including telemonitoring.[24] In addition, it has been reported that telemedicine has the potential to provide significant cost savings by increasing patients' working ability, independent living ability, quality of life, and reducing travel costs.[25]

Literature Review

Kaur, et al (2015) findings that revealed that proper and more frequent telecommunication between patients and healthcare providers results in better adherence to medications and interventions and overall better diabetes care.[26]

Another two studies from Japan 27 and Saudi Arabia40 reported similar positive clinical outcomes in terms of glycemic control. In addition, it has been shown that increasing patient contact through frequent phone calls improves patient therapy adherence, motivation, and metabolic control.[27] However, only limited literature is currently available on the cost-effectiveness of telemedicine for diabetes care.[28-29]

Chronic Illness Center indicates that telemedicine has a role in the clinical care of patients with DM. Moreover, the patient response to telemedicine services was encouraging. In fact, overall, high of patients answered the calls and attended the virtual clinics in hospital during the period from March to June 2020, based on the statistics of the appointment department at our institution.[30]

Our findings regarding the impact of telemedicine care on improving the outcomes of patients with DM is consistent with other studies reported in the literature.[31] For instance, one of the largest studies conducted to investigate the effect of telemedicine on DM outcomes is the Informatics for Diabetes Education and Telemedicine project that included 1665 patients. This randomized controlled trial compared the outcomes of DM patients provided

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with telemedicine care with DM patients not enrolled in telemedicine system.[32] The study participants in this project showed improvements in glycaemic control, blood pressure readings and cholesterol levels after following the participants for 1 year.[33]

Timpel, et al 2020 report that telemedicine (i.e. teleconsultations) encompassing frequent and intense patient–healthcare provider communication interactions resulted in significant clinically relevant reductions in HbA1c (−1.20%, 95% CI = −2.30 to −0.10; $p < 0.001$).[34]

Rationale:

Telemedicine can offer a convenient way of expanding access to healthcare in Saudi Arabia accurately and cost-effectively while minimizing the risk of COVID-19 transmission. More efforts should be exerted to provide healthcare settings with technical equipment and training needed for telemedicine. Regulations to implement telemedicine on a large scale in Saudi Arabia while protecting data privacy are also needed, as a result of adopting the Diabetes Telemedicine Clinic, we were able to successfully reduce the number of patients, HCPs, and staff physically present in the clinics without negatively impacting the quality of care provided to our patients nor their satisfaction with the visits. Though we hope that our quick adoption of a Diabetes Telemedicine Clinic during the COVID-19 pandemic will translate into a clinically meaningful impact on patients who attended the clinic, this will need to be examined in future studies. Prevention and health promotion is one of the cornerstones in our practice, thus Telemedicine in care for patients with uncontrolled type 2 diabetes mellitus during the COVID-19 pandemic very important.

Aim of the study:

To assessment of the Cost-effectiveness of telemedicine care for patients with uncontrolled type 2 diabetes mellitus during the COVID-19 pandemic in Makkah Al-Mokarramah, Saudi Arabia 2022

Objectives:

This study assessment the cost-effectiveness of telemedicine for patients with uncontrolled type 2 diabetes mellitus (i.e. HbA1c >9) .

Methodology:

Study design:

This study is a cross sectional descriptive study

Study Area

Adult patients aged <25 to >60 years and above with uncontrolled type 2 DM attending in primary health care outpatient in the diabetes center, the patients were recruited from an integrated care clinic at the diabetes center and clinics of the Family and Community Medicine Department at Makkah Al-Mokarrama, .in Makkah Al-Mokarramah, Saudi Arabia at diabetes center and clinics of the Family and Community Medicine Department, high-risk patients with uncontrolled type 2 diabetes (i.e. HbA1c > 9) are referred to this diabetes center

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and clinics of the Family and Community Medicine Department from, the patients receive comprehensive diabetes care (i.e. intensive diabetic)

Study Population

The study has been conducted among adult patients aged <25 to >60 years and above with uncontrolled type 2 DM attending in primary health care outpatient in the Diabetic Center, family and Community Medicine Department in the Makkah, from July and September 2022

Selection criteria:

Inclusion criteria

- In this study, the inclusion criteria included the following: adult patients with type 2 DM with an HbA1c value > 9 (i.e. uncontrolled diabetes) before the study period and with a valid HbA1c value after the follow-up period.

Exclusion criteria :

- All patients aged < 25 years and those with HbA1c values < 9 at baseline or patients with no HbA1c values after receiving telemedicine care or traditional care were excluded. Based on these inclusion and exclusion criteria, in the traditional care model, we included all the first 107 patients who met the criteria. Socio economic and clinical characteristics, such as age, sex, and comorbidities, were included in the telemedicine care . Hence, to include the patients managed through telemedicine and traditional care (107 patients).

Sample size

The sample size has been calculated by applying Raosoft sample size calculator based on (The margin of error: 5%, Confidence level: 95%, and the response distribution was considered to be 20%) accordingly the Sample size is 107 of diabetic patients attending and adding 10 more to decrease margin of error. After adding 5% oversampling, the minimum calculated sample has been 107. Computer generated simple random sampling technique was used to select the study participants.

Sampling technique :

Systematic random sampling technique is adopted. By using systematic sampling random as dividing the total population by the required sample size; (107)

Data collection tool

- Patients who were managed using traditional and elemedicine care models were identified through electronic medical records. Patients were followed for at least 3 months to assess the impact of either health delivery model (i.e. telemedicine versus traditional) on the HbA1c level .
- Patients' age, sex, disease duration, follow-up period, comorbidities, baseline and follow-up HbA1c levels, laboratory tests (e.g. complete blood count, serum creatinine, liver function tests, HbA1c), medications, medical supplies (e.g. glucometer, swabs, lancets, lancing pens, strips), shipping, and the frequency of physical and virtual clinic visits were collected.

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- Consequently, the costs, namely the costs of medications, laboratory tests, medical supplies, shipping, phone calls, and clinic visits (in-person and virtual visits), were collected. The costs of visits to the clinic and laboratory tests were retrieved from the cost center of the Ministry of Health, Saudi Arabia.
- The costs of medications, medical supplies, phone calls, and shipping of medicines and medical supplies were retrieved from the relevant departments .

The researcher has been examining the reliability of the questionnaire by testing and retesting.

The questionnaire was translated to local language and then, retranslated back to English by another person to check its consistency and wording.

Data collection technique:

Researcher has been visits the selected Diabetic Center after getting the approval from the ministry of health. She has been explained the purpose of the study to all participants attending the clinic. The data has been collect through the July and September 2022.

Data entry and analysis:

The Statistical Package for Social Sciences (SPSS) software version 24.0 has been used for data entry and analysis. Descriptive statistics (e.g., number, percentage) and analytic statistics using test for the association and the difference between two categorical variables were applied. A p-value ≤ 0.05 has been considered statistically significant.

Pilot study:

A pilot study has been conducted to test the methodology of the study, the questionnaire has been clear **.**

Ethical considerations:

Permission has been obtained, and has been Verbal consents from all participants in the questionnaire were obtained.

All information was kept confidential, and a result has been submitted to the department as feedback.

Budget:

Self-funded

Results

Table 1 Distribution of demographic data(age, gender, Level of education, Nationality, Marital status, economic level) **in our study(n=107).**

	N	**%**
Age		
<25	7	6.5
25-50	82	76.6
50-60	11	10.3
>60	7	6.5
Gender		
Female	38	35.5

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Male	69	64.5
Level of education		
Primary	4	3.7
Intermediate	6	5.6
Secondary	26	24.3
High education	71	66.4
Nationality		
Saudi	91	85.0
Non-Saudi	16	15.0
Marital status		
Single	28	26.2
Married	74	69.2
Divorced	3	2.8
Widow	2	1.9
Smoking		
Smoker	21	19.6
Non-smoker	86	80.4
Economic level		
Low	19	17.8
Average	80	74.8
High	8	7.5

Table 1 shows there were 107 participants, and the majority age was(76.0%) in (25-50)years, while the age(50-60)were(20.3%), the majority of them were males (64.5%) while female(35.5%),also regarding the Level of education most of participants high education were(66.4%), regarding the Nationality most of participants Saudi were(85.0%), regarding the Marital status most of participants Married were(69.2%), while single were(26.2%), regarding Smoking the majority of participant are Non-smoker were(80.4%) . Regarding the economic level the majority of participant average economic level were(74.8%).

Table 2. Distribution of characteristics of the patients

	N	**%**
Sources of information about telemedicine care		
Booklets and brochures	14	13.1
Mass media	34	31.8
Own personal experience	21	19.6
Educational films	13	12.1
Medical education in health centres	22	20.6

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and hospitals		
Others	3	2.8
The Comorbidities of type 2 diabetes		
Congestive heart failure	6	5.6
Chronic kidney disease	20	18.7
Stroke	7	6.5
Cardiovascular disease	21	19.6
Dyslipidemia	2	1.9
Depression	17	15.9
Hypertension	28	26.2
Hypothyroidism	6	5.6

Regarding the Sources of information about telemedicine care the majority of participant from Mass media were(31.8%), while Medical education in health centres and hospitals were (20.6%) , regarding the The Comorbidities of type 2 diabetes the majority of participant Hypertension were(26.2%), followed by Cardiovascular disease were (19.0%) while Chronic kidney disease were (18.7%)

Table 3. Distribution Characteristics of Patients Who Visited the Diabetes Telemedicine Clinic and changes in the HbA1c after > 3 months of follow-up and the costs of treatment for the telemedicine .

	N	**%**
Number of comorbidities		
<2	55	51.4
2–4.	38	35.5
4–6.	14	13.1
Disease duration		
Less than 1 years	20	18.7
2–4 years	27	25.2
4–6years	15	14.0
More than 6 years	45	42.1
Rang of HbA1c, glycated hemoglobin		
4 – 5.6% (20 – 38 mmol/mol)	35	32.7
values between 5.7% and 6.4% (39 – 46 mmol/mol)	42	39.3
over 6.5% (47 mmol/mol)	30	28.0
Impact of patients in after > 3 months of follow-up and the costs of treatment for the telemedicine		
Had a mean reduction in their HbA1c level	53	49.5

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Had a mean increased in their HbA1c level	27	25.2
No differences in their HbA1c level	27	25.2
The costs of treatment for the telemedicine		
less than cost of the traditional care model	43	40.2
More than cost of the traditional care model	20	18.7
I don't know	44	41.1

Table 3 shows regarding the Characteristics of Patients Who Visited the Diabetes Telemedicine Clinic. ,regarding the number of comorbidities the majority of participant <2 were (51.4%)followed by 2-4 were (35.5%), regarding the Disease duration most of participants more than 6 years were(42.1%), regarding the Rang of HbA1c, glycated hemoglobin shown the majority of participant in values between 5.7% and 6.4% (39 – 46 mmol/mol) were (39.3%) followed by 4 – 5.6% (20 – 38 mmol/mol)were(32.7%) followed by over 6.5% (47 mmol/mol) were(28.0%), regarding Impact of patients in after > 3 months of follow-up and the costs of treatment for the telemedicine the majority of participant answer(I don't know) were(41.1%), followed less than cost of the traditional care model were(40.2%) while more than cost of the traditional care modelwere918.7%).

Figure 1. Distribution Impact of patients in after >3 months of follow-up and the costs of treatment for the telemedicine .

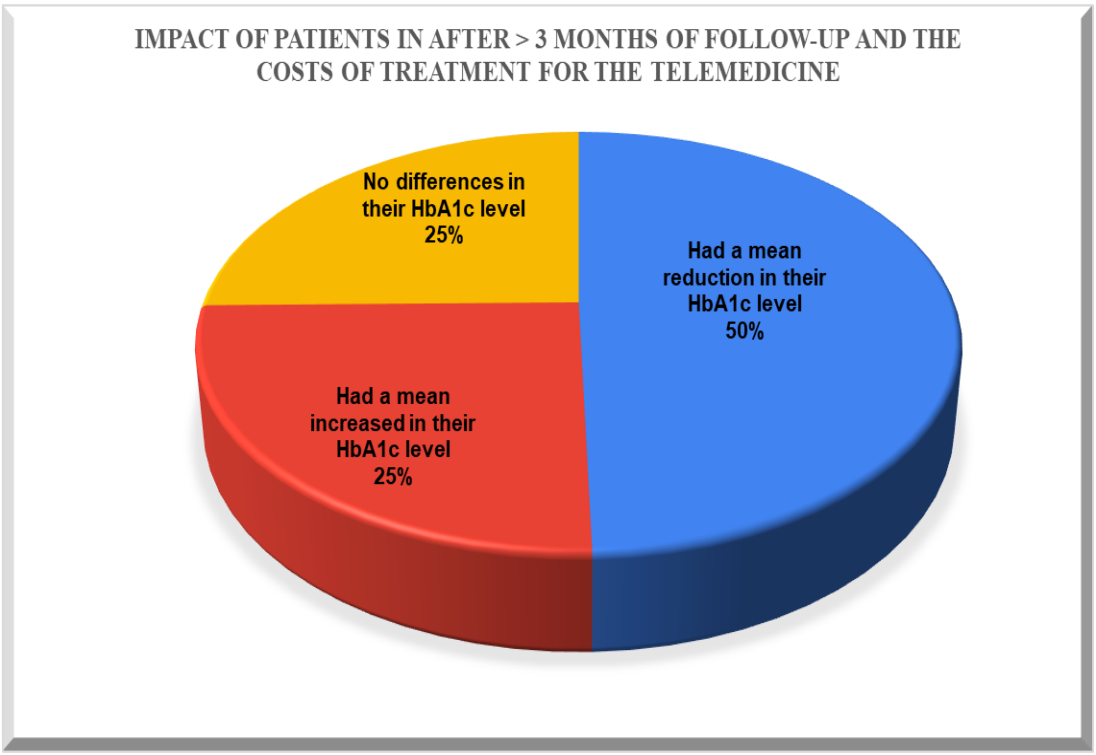

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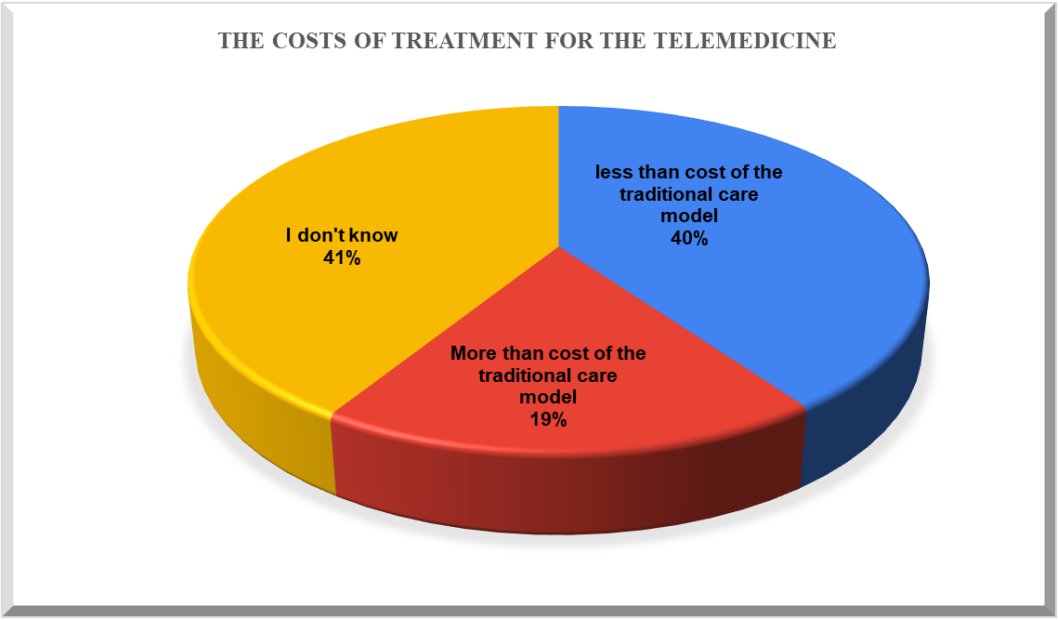
Figure 2. Distribution costs of treatment for the telemedicine .



Table(4) Distribution of the relation of the costs of treatment for the telemedicine and the demographic data (age, gender, Level of education, Nationality, Marital status, economic level)

			The costs of treatment for the telemedicine			Total	Chi-square	
			less than cost of the traditional care model	More than cost of the traditional care model	I don't know		X^2	P-value
Age	<25	N	4	0	3	7	7.059	0.315
		%	9.3%	0.0%	6.8%	6.5%		
	25-50	N	33	16	33	82		
		%	76.7%	80.0%	75.0%	76.6%		
	50-60	N	5	1	5	11		
		%	11.6%	5.0%	11.4%	10.3%		
	>60	N	1	3	3	7		
		%	2.3%	15.0%	6.8%	6.5%		
Gender	Female	N	13	10	15	38	2.330	0.312
		%	30.2%	50.0%	34.1%	35.5%		
	Male	N	30	10	29	69		
		%	69.8%	50.0%	65.9%	64.5%		
Level of educatio	Primary	N	0	3	1	4	13.400	0.037*
		%	0.0%	15.0%	2.3%	3.7%		

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n	**Intermediate**	**N**	3	2	1	6		
		%	7.0%	10.0%	2.3%	5.6%		
	Secondary	**N**	7	4	15	26		
		%	16.3%	20.0%	34.1%	24.3%		
	High education	**N**	33	11	27	71		
		%	76.7%	55.0%	61.4%	66.4%		
Nationality	**Saudi**	**N**	36	16	39	91	0.906	0.636
		%	83.7%	80.0%	88.6%	85.0%		
	Non-Saudi	**N**	7	4	5	16		
		%	16.3%	20.0%	11.4%	15.0%		
Marital status	**Single**	**N**	11	6	11	28	4.164	0.655
		%	25.6%	30.0%	25.0%	26.2%		
	Married	**N**	31	13	30	74		
		%	72.1%	65.0%	68.2%	69.2%		
	Divorced	**N**	0	1	2	3		
		%	0.0%	5.0%	4.5%	2.8%		
	Widow	**N**	1	0	1	2		
		%	2.3%	0.0%	2.3%	1.9%		
Smoking	**Smoker**	**N**	9	3	9	21	0.354	0.838
		%	20.9%	15.0%	20.5%	19.6%		
	Non-smoker	**N**	34	17	35	86		
		%	79.1%	85.0%	79.5%	80.4%		
Economic level	**Low**	**N**	7	6	6	19	2.883	0.578
		%	16.3%	30.0%	13.6%	17.8%		
	Average	**N**	33	12	35	80		
		%	76.7%	60.0%	79.5%	74.8%		
	High	**N**	3	2	3	8		
		%	7.0%	10.0%	6.8%	7.5%		

Table (4) show that is relation between The costs of treatment for the telemedicine and demographic data regarding age no significant relation (increase in 25-50 in More than cost of the traditional care model follow by less than cost of the traditional care model and I don't know)were respectively (80.0%,76.7% and 75.6%) and P-value=<0.315 X^2 7.059. Regarding gender in our study the majority of our participants were noticed in male more than female with no significant relation between The costs of treatment for the telemedicine and gender (increase in less than cost of the traditional care model were 69.8%) and X^2 74.858 and no significant relation were P-value=0.000. regarding to the Level of education show that is a significant relation between The costs of treatment for the telemedicine and Level of education (increase in High education in less than cost of the traditional care model)were (76.7%) and X^2 13.400 P-value=0.037, regarding to the Nationality show that is no significant relation between The costs of treatment for the telemedicine and Nationality

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(increase in Saudi in I don't know)were (88.6%) and X^2 0.906 P-value=0.636. Regarding marital status show that is no significant relation between The costs of treatment for the telemedicine and marital status (increase in married in less than cost of the traditional care model)were (72.1%) and X^2 4.164 P-value=0.655, regarding Smoking no significant relation between The costs of treatment for the telemedicine (increase in Non-smoker in More than cost of the traditional care model) were (85.0%) and P-value=<0.838 X^2 0.354. Regarding Economic level no significant relation between The costs of treatment for the telemedicine and Economic level (increase in average in less than cost of the traditional care model were 76.7%) and X^2 2.883 and were P-value=0.578.

Table(5) Distribution of the relation of the Impact of patients in after > 3 months of follow-up and the costs of treatment for the telemedicine and the demographic data (age, gender, Level of education, Nationality, Marital status, economic level)

			Impact of patients in after > 3 months of follow-up and the costs of treatment for the telemedicine			**Total**	**Chi-square**	
			Had a mean reduction in their HbA1c level	**Had a mean increased in their HbA1c level**	**No differences in their HbA1c level**		**X^2**	**P-value**
Age	**<25**	**N**	3	3	1	7	9.417	0.151
		%	5.7%	11.1%	3.7%	6.5%		
	25-50	**N**	41	21	20	82		
		%	77.4%	77.8%	74.1%	76.6%		
	50-60	**N**	6	0	5	11		
		%	11.3%	0.0%	18.5%	10.3%		
	>60	**N**	3	3	1	7		
		%	5.7%	11.1%	3.7%	6.5%		
Gender	**Female**	**N**	18	5	15	38	8.328	0.016*
		%	34.0%	18.5%	55.6%	35.5%		
	Male	**N**	35	22	12	69		
		%	66.0%	81.5%	44.4%	64.5%		
Level of education	**Primary**	**N**	1	3	0	4	7.224	0.301
		%	1.9%	11.1%	0.0%	3.7%		
	Intermediate	**N**	4	1	1	6		
		%	7.5%	3.7%	3.7%	5.6%		
	Secondary	**N**	11	6	9	26		
		%	20.8%	22.2%	33.3%	24.3%		

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	High education	**N**	37	17	17	71		
		%	69.8%	63.0%	63.0%	66.4%		
Nationality	**Saudi**	**N**	43	23	25	91	2.039	0.361
		%	81.1%	85.2%	92.6%	85.0%		
	Non-Saudi	**N**	10	4	2	16		
		%	18.9%	14.8%	7.4%	15.0%		
Marital status	**Single**	**N**	14	8	6	28	6.216	0.399
		%	26.4%	29.6%	22.2%	26.2%		
	Married	**N**	38	18	18	74		
		%	71.7%	66.7%	66.7%	69.2%		
	Divorced	**N**	0	1	2	3		
		%	0.0%	3.7%	7.4%	2.8%		
	Widow	**N**	1	0	1	2		
		%	1.9%	0.0%	3.7%	1.9%		
Smoking	**Smoker**	**N**	8	11	2	21	10.230	0.006*
		%	15.1%	40.7%	7.4%	19.6%		
	Non-smoker	**N**	45	16	25	86		
		%	84.9%	59.3%	92.6%	80.4%		
Economic level	**Low**	**N**	10	6	3	19	5.927	0.205
		%	18.9%	22.2%	11.1%	17.8%		
	Average	**N**	38	21	21	80		
		%	71.7%	77.8%	77.8%	74.8%		
	High	**N**	5	0	3	8		
		%	9.4%	0.0%	11.1%	7.5%		

Table (5) show that is relation between The Impact of patients in after > 3 months of follow-up and the costs of treatment for the telemedicine and demographic data, regarding age no significant relation (increase in 25-50 in Had a mean increased in their HbA1c level follow by Had a mean reduction in their HbA1c level and No differences in their HbA1c level) were respectively (77.8%,77.4% and 74.1%) and P-value=<0.151 X^2 9.417, regarding to the Gender show that is a significant relation between Impact of patients in after > 3 months of follow-up and the costs of treatment for the telemedicine and gender (increase in male in Had a mean increased in their HbA1c level) were (81.5%) and P-value=<0.016 X^2 8328. Regarding Level of education no significant relation between the Impact of patients in after > 3 months of follow-up and the costs of treatment for the telemedicine and Level of education (increase in High education in Had a mean reduction in their HbA1c level) were (69.8%) and P-value=<0.301 X^2 7.224. regarding to the Nationality show that is no significant relation between Impact of patients in after > 3 months of follow-up and the costs of treatment for the telemedicine and Nationality (increase in Saudi in No differences in their HbA1c level) were (92.6%) and P-value=0.361 X^2 2.039. Regarding No differences in their HbA1c level no significant relation between the Impact of patients in after > 3 months of follow-up and Marital status (increase in married in Had a mean reduction in their HbA1c

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level) were (71.7%) and P-value=0.399 X^2 6.216. regarding to the Smoking show that is a significant relation between Impact of patients in after > 3 months of follow-up and the costs of treatment for the telemedicine and Smoking (increase in non- Smoking in No differences in their HbA1c level) were (92.6%%) and P-value=0.006 X^2 10.230. Regarding Economic level no significant relation between the Impact of patients in after > 3 months of follow-up and Economic level (increase in Average in Had a mean increased in their HbA1c level and No differences in their HbA1c level) were (77.8%) and P-value=5.927 X^2 0.205.

Discussion

We undertook the current study to assessment of the Cost-effectiveness of telemedicine care for patients with uncontrolled type 2 diabetes mellitus during the COVID-19 pandemic in Makkah Al-Mokarramah, Saudi Arabia 2022. The current study provides new insights into the clinical and economic impact of implementing a telemedicine service to a high-risk group of patients with uncontrolled diabetes during the COVID-19 pandemic. The enrolled patients in the study had a baseline HbA1c , and the vast majority of patients were suffering from other comorbidities such as dyslipidemia and hypertension. Despite this, the findings of this study demonstrate a significant difference in HbA1c after the virtual clinic, with a reduction in HbA1c . Moreover, telemedicine care successfully decreased the need for in-person care visits. Typically, before the pandemic, one visit every 1–2 weeks was needed for this high-risk group of patients with DM in our intensified integrated care program .[32]

Furthermore, the effect of HbA1c level was more favorable for those who were managed through the telemedicine care model for the telemedicine care model versus for the traditional care model. This could be explained by the frequent remote follow-ups and telecommunications that were provided for the patients who were managed through the telemedicine care model during the pandemic. In fact, as the integrated clinic is established to specifically manage high-risk patients with type 2 DM (i.e. uncontrolled diabetes), the virtual appointments were scheduled every 1–2 weeks in the first 3 months of patient enrollment in this specialized clinic. However, the traditional care model during the pandemic had less frequent in-person visits in the clinic due to preventive and precautionary measures (i.e. typically one in-person care consultation per month). This is in line with the findings in the literature that revealed that proper and more frequent telecommunication between patients and healthcare providers results in better adherence to medications and interventions and overall better diabetes care.[26]

Consequently, telemedicine not only helped with glycaemic control, but has managed to reduce the risk of exposure to infection by having a minimal number of visits. This in turn indicates that telemedicine has a role in the clinical care of patients with DM. Moreover, the patient response to telemedicine services was encouraging. based on the statistics of the appointment department at our institution.[35]

Moreover, our findings regarding the reduction in HbA1c levels after virtual care are in line with the findings of a systematic review and meta-analysis that included 35 randomized controlled trials on the effect of various telemedicine approaches on glycaemic control in patients with type 2 DM. The findings of the meta-analysis showed that telemedicine over 3–60 months had a significant reduction in HbA1c by −0.37% in the telemedicine group as

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compared with the controls.[36] Moreover, the findings of a Cochrane review by Flodgren and colleagues reported a significantly lower HbA1c levels in patients allocated to telemedicine than in controls at a median of 9 months of follow-up.[37] Similarly, a recent umbrella review of systematic reviews and meta-analyses was conducted to assess the effectiveness of telemedicine on clinical outcomes in patients with chronic conditions including DM.33 the another review showed that there were clinically significant improvements in HbA1c levels in patients with DM who received telemedicine care.[33]
Moreover, telemedicine (i.e. teleconsultations) encompassing frequent and intense patient–healthcare provider communication interactions resulted insignificant clinically relevant reductions in HbA1c .[34]
Therefore, the implementation of telemedicine has the benefit of increasing patient–healthcare provider contact without the risk of infection and exposure during the COVID-19 pandemic. Several studies have reported the clinical effectiveness of telemedicine interventions on HbA1c levels. For example, according to a systematic review and meta-analysis by [33] and colleagues, [33] a statistically significant reduction in the HbA1c level in the telemedicine group compared with that of the control group was reported . Moreover, a recent metaanalysis by Correia and colleagues,[38] which focused on telemedicine interventions implemented in low- and middle-income countries, indicated that telemedicine interventions were effective for diabetes management and resulted in significant reductions in HbA1c levels . In a study from Japan, Onishi and colleagues.[27] reported that among patients with diabetes having HbA1c $\geqslant$ 7% before the pandemic outbreak, providing diabetes care through telemedicine during the state of emergency resulted in an improvement to HbA1c < 7% after the emergency period in Japan. In addition to the clinical benefit, the patients on telecare also reported feeling more secure and more care, and the telecare helped the patients and their families take more active roles in their diabetes self-care management.[30]

Conclusions

The current study found a significant positive effect of telemedicine care on glycaemic control among high-risk patients with DM during the COVID-19 pandemic. Moreover, a result of adopting the Diabetes Telemedicine Clinic, we were able to successfully reduce the number of patients, HCPs, and staff physically present in the clinics without negatively impacting the quality of care provided to neither our patients nor their satisfaction with the visits. Though we hope that our quick adoption of a Diabetes Telemedicine Clinic during the COVID-19 pandemic will translate into a clinically meaningful impact on patients who attended the clinic, this will need to be examined in future studies. It showed that telemedicine could be integrated into the diabetic care to successfully replace many of the usual in-person care visits. In addition, health policy makers need to consider developing comprehensive guidelines in Saudi Arabia to promote best practice of telemedicine to ensure the quality of care, and address issues such as financial reimbursement and patient information privacy.

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