Validity Study of Video Teleconsultation for the Management of Diabetes: A Pilot Randomized Controlled Trial

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Abstract

**Background:** A large proportion of diabetes patients do not receive a basic minimum of standard care. Telemedicine holds the promise of improving access to health care. However, the validity of remote consultation for diabetes has not been well researched. This pilot randomized control trial was designed to evaluate the agreement on prescription decisions of endocrinologists between two consultation formats: videoconferencing and face-to-face (in-person) consultation.

**Patients and Methods:** Seventy-three patients were randomized to telemedicine (n = 36) and reference group (n = 37). Each study patient in the telemedicine group received one face-to-face consultation and one video consultation. The reference group received two face-to-face consultations. The paired consultations for each patient were performed by two different endocrinologists. The level of agreement between endocrinologists was evaluated by comparing their recommendations on antidiabetes and cardioprotective medications.

**Results:** The level of agreement between two endocrinologists on changing antidiabetes drugs was 64% in the telemedicine group and 78% in the reference group. Although the level of agreement was lower when one of the consultations was provided via videoconference, the difference was not significant. The level of agreement on changing cardiovascular drugs was 78% in the telemedicine group and 76% in the reference group, again not significantly different.

**Conclusions:** The results of this study demonstrate the preliminary evidence on the validity of recommendations made by endocrinologists via video consultation. Known limitations of videoconferencing for clinical purposes did not have remarkable impact on the outcome of consultation in terms of adjustment of patient's medications. Video teleconsultation can substitute for a considerable proportion of conventional outpatient specialty consultations for people with diabetes.

Introduction

**Diabetes Mellitus Imposes Unacceptably High Human, Social, and Economic Costs Globally.** Currently 8.3% of adults worldwide are estimated to have diabetes.1 Patients with diabetes are at increased risk of various life-threatening conditions, and intensive glycemic control reduces the risk of developing diabetes-related complications.2 However, large proportions of people with type 2 diabetes do not receive a basic minimum standard of care that is recommended by international guidelines.3 Alarming large proportions of patients with poor glycemic control have a delay in receiving intensified treatment for hyperglycemia (clinical inertia)4 or continue to remain with poor glycemic control even after the initiation of intensified treatment (glycemic burden).5 There is inequality in access to specialty care between the residents

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This study is registered with the Australian New Zealand Clinical Trials Registry under trial registration number ACTRN12612000315819.
of rural areas and metropolitan areas, with people with diabetes who live in rural areas less likely to have access to adequate diabetes care. Geographical, social, and cultural barriers limit access to appropriate care for many people around the world. Improving access to timely and quality care is the fundamental requirement for effective management of this chronic disease.

Telemedicine, defined as the provision of health care at a distance using information and communication technologies, holds the promise of improving access to specialized care. Review of the literature shows that telemedicine projects are increasingly reported by both developed and developing countries. Several systematic reviews have summarized the results of trials on telemedicine applications for diabetes care, but almost all of the studies under review have used telemedicine for behavioral therapy interventions such as diabetes education, self-management training, and nutrition consultations, which are commonly provided by nonphysician health professionals.

One of the synchronous modalities of telemedicine is videoconferencing, which constitutes real-time exchange of image and voice between two or more parties. The popularity of videoconferencing for clinical purposes has increased substantially in recent years. Rapid advancements in information technology and telecommunications systems have made it more available and less costly. Video teleconsultation has certain advantages over face-to-face (FTF) (in-person) consultation. Most important is that it can bridge the geographical gap between healthcare providers and consumers and avoid the costs and inconvenience of long-range trips to the cities where the needed expertise is available. Nevertheless, there are several disadvantages associated with telemedicine interventions, including video consultations. Inability of the healthcare practitioner to physically examine the patient and establish rapport, potential failure in video or audio communication, and the need for acceptance of a new medium of healthcare delivery by the users are among the main limiting factors of video teleconsultation.

A few studies have compared video-based versus FTF encounters for the management of diabetes. Izquierdo et al. studied the effectiveness of diabetes education administered via telemedicine and compared its results with FTF education. Videoconferencing was one of the components of a telemedicine system that was used in a large clinical trial for the management of older people with diabetes. However, in both of these studies videoconferencing was used by a nurse or dietitian, not a specialist physician.

To the best of our knowledge, no study has assessed the validity of video consultation, compared with conventional FTF consultation, for specialist medical care of patients with diabetes. This pilot study was designed to assess the validity of videoconferencing for clinical management of diabetes from distance by endocrinologists. We sought to generate initial evidence for the possible impact of the modality of consultation (i.e., videoconferencing versus FTF) on the level of agreement between the endocrinologists when consulting people with diabetes. The outcome measures were changes in prescribing of antidiabetes, antihypertensive, and lipid-lowering drugs. The primary aim of the study was to compare the level of agreement between endocrinologists in terms of changes in antidiabetes drugs in the telemedicine and reference groups. The secondary aim was to compare the levels of agreement between endocrinologists for changes in antihypertensive and lipid-lowering drugs.

**Patients and Methods**

**Participants and setting**

This study was conducted in the diabetes outpatient clinic of Princess Alexandra Hospital, Brisbane, Australia. Princess Alexandra Hospital is a tertiary teaching hospital that serves more than 1 million residents of the Brisbane southern area. It also receives referral patients from all over the Queensland state as well as from neighboring states of Australia. Participants were people with diabetes who had an appointment with endocrinologists at the Princess Alexandra Hospital diabetes outpatient clinic. They were referred mainly by their general practitioner (GP) for specialist consultation on the management of their diabetes. Inclusion criteria consisted of a confirmed diagnosis of type 1 or 2 diabetes and age of 18 years or more. Patients were excluded if they were severely ill, unable to communicate effectively (e.g., blind, deaf, or mute), or speaking in a language other than English when an interpreter was not available. The recruitment occurred between October 2012 and July 2013.

Eligible patients were invited to participate in the study upon registering at the clinic. Written consent was obtained from those who were willing to enroll in the study. Two movie vouchers were offered as an honorarium to each participant. Patients who opted not to participate in the study received the routine service of the clinic. The protocol of the study was approved by the Human Research Ethics Committees of both Queensland Health and The University of Queensland. The study protocol has been published in detail elsewhere.

**Randomization**

Participants were randomly allocated in a 1:1 ratio to one of two study groups: reference group or telemedicine group. In the reference group, participants received two FTF consultations. The telemedicine group received one FTF and one videoconference (VC) consultation. A block randomization with the block size of 8 was used to ensure balanced representation of participants in each group. The randomized configuration was prepared by an independent biostatistician using SAS software (SAS Institute, Cary, NC). Opaque sealed envelopes with sequential numbers were used for allocating the participants into the study groups. The randomization process also determined the order of consultations for the participants in the telemedicine group: FTF followed by VC (FTF-VC) or VC followed by FTF (VC-FTF). The three potential configurations for the paired consultations of each participant are shown in Table 1.

**Intervention**

All participants received two consultations conducted by two different endocrinologists, one after the other during the same clinical session. The first consultation was always conducted by the same endocrinologist (referred to as “Doctor A” in this article), who was a practicing clinician and employed specifically for the purpose of this study. The second consultation was performed by one of the five clinic endocrinologists who all participated in the study (collectively
referred to as “Doctor B” in this article). Assignment of the participants to one of the clinic endocrinologists for the second consultation was according to the clinic routine by which each patient is usually assigned to the endocrinologist who consulted the patient in the previous appointment. Final recommendations for each participant were made at the end of the second consultation by Doctor B. In the telemedicine group, video consultations were evenly assigned to Doctor A (the first consultation) and Doctor B (the second consultation) as determined by the randomization process. Both Doctor A and Doctor B had access to the same background medical information for each patient. All the doctors participating in this study were endocrinologists with similar qualifications and accreditations (i.e., accredited by the Royal Australian College of Physicians).

Equipment and connectivity

VC, for the telemedicine group, was established between two rooms in the same building of the clinic. The telehealth studio of the clinic, where patients sat for teleconsultation, is equipped with a Tandberg codec 990MXP + camera unit (Cisco Systems, San Jose, CA), a Sony (Tokyo, Japan) Bravia 32-inch television, and an Audio-Technica microphone (Audi-Technica Australia, Stanmore, NSW, Australia). The camera features pan, tilt, and zoom functions. The endocrinologists used a laptop with a 13-inch screen and Cisco Telepresence Movi software version 4.2 to connect to the telehealth studio (Fig. 1). Both the Tandberg codec and Cisco Movi are H.264 compliant and capable of high-definition video (up to 1080 pixels, 30 frames/s) encoding and decoding. The connection was via Internet protocol at 384 kbits/s. This bandwidth is generally regarded as the minimum connection speed for producing an acceptable clinical VC. The minimum required bandwidth was selected to improve the generalizability of the results of this study to the locations where high-speed networks are not readily available.

Data collection and statistical analyses

A data collection form was developed based on findings of previous studies that analyzed the process of specialist consultations in the same diabetes outpatient clinic.20,21 The endocrinologists were asked to complete the form for each consultation they provided. In addition to demographic and baseline status questions, four categories of drugs were included in the form: insulin, other antidiabetes drugs (oral and injectable noninsulin drugs), antihypertensive drugs, and lipid-lowering drugs. In each category four possible types of change were considered: initiation, dose adjustment, change in regimen (type, frequency), and cessation. If any of these four changes had been indicated by the endocrinologist for a drug as the recommendation of the consultation, that drug was marked as “changed.” For statistical analysis of drug change, insulin and other antidiabetes drugs were consolidated into a group called “antidiabetes drug.” Similarly, antihypertensive and lipid-lowering drugs were also grouped to form “cardioprotective drugs.” The status of each group was regarded as “changed” if at least one drug in that group had been marked as changed; otherwise, it was regarded as “not changed.”

Basic statistics on patients’ characteristics were presented by number (%), mean (SD), or median (interquartile range). The differences in the distributions of individual characteristics between the telemedicine and reference groups were tested using appropriate parametric or nonparametric statistical tests. The raw agreement between two endocrinologists was presented by percentage separately for the telemedicine and reference groups. The Cohen’s k statistics and the areas under the receiver operator characteristic estimates were obtained along with their 95% confidence intervals (CI). For areas under the receiver operator characteristic estimation, bootstrapped estimates of CI were obtained. The comparisons of possible differences in the k and areas under the receiver operator characteristic estimates between the reference and telemedicine groups were based on the upper and lower limits of the estimated 95% CIs.

In total, 75 patients were recruited from October 2012 to July 2013. Two patients were seen by a registrar (specialty trainee) instead of the intended endocrinologists because of administrative failure and thus were excluded from the study. Therefore data analysis was performed on 146 consultations provided for 73 patients. Based on the randomization process, 37 patients were allocated to the reference group and 36 patients to the telemedicine group. The Consolidated Standards of Reporting Trials (CONSORT) study flow is shown in Figure 2.

Results

Participants

The mean (SD) age of the patients was 57 (14) years (range, 24–83 years), and 34% were female. The two groups were similar on key baseline characteristics (Table 2).

Level of agreement between doctors in changing antidiabetes drugs

The observed agreement between the endocrinologists for changing antidiabetes drugs was 78% (29/37) in the reference group and 64% (23/36) in the telemedicine group (Table 3). Cohen’s k test showed moderate agreement (0.42; 95% CI, 0.27–0.55) in the reference group and fair agreement (0.31; 95% CI, 0.09–0.52) in the telemedicine group. However, the difference between the two groups was not statistically significant. The area under the receiver operator characteristic curve for the reference group and the telemedicine group was 0.76 and 0.69, respectively (Table 3).

Level of agreement between doctors in changing cardioprotective drugs

The level of observed agreement between the endocrinologists for changing cardioprotective drugs was 76% (28/37) in the reference group and 78% (28/36) in the
telemedicine group. Cohen’s κ test showed fair agreement in both the reference group (0.27; 95% CI, 0.11–0.39) and the telemedicine group (0.37; 0.15–0.75) (Table 3).

Impact of the mode of consultation on recommendations made by the endocrinologists

For the patients in the telemedicine group, the endocrinologists changed antidiabetes drugs in 61% of patients when consulted FTF and 47% when consulted via VC. Changes in cardioprotective drugs were recommended in 31% for FTF consultations and 14% in video consultations. Overall changes recommended for the patients in the telemedicine group was 72% when consulted FTF and 58% when consulted via VC (Table 4).

Discussion

This pilot trial indicates that the outcome of consultations provided by endocrinologists via videoconferencing is similar to those of FTF encounters in terms of changes in drug prescription. The level of agreement in changing antidiabetes drugs between endocrinologists in the telemedicine group (64%) was lower than that of the reference group (78%), but this difference was not statistically significant. The between-group difference in the level of agreement in changing cardiovascular drugs was also neither statistically nor clinically significant.

The most obvious limiting factor of using telemedicine for clinical consultation of the patients is the inability to performing a physical examination. The assessment of a diabetes patient, compared with a cardiovascular or respiratory
patient, relies more on the results of laboratory tests (i.e., blood glucose levels and hemoglobin A1c) rather than the findings from physical examination. However, it is possible in many disciplines to request a GP or a nurse practitioner who accompanies the patient at the remote site to perform the required physical examination and report the findings back to the specialist (e.g., examination of feet for evidence of neuropathy and peripheral vascular disease, as well as injection sites for lipohypertrophy).21 Logically, it seems that the more a consultation is dependent on a specialized physical examination, the less it will be suitable for telemedicine.

Any inferiority in the clinical outcome of teleconsultations, either via store-and-forward applications such as e-mail or synchronous applications such as videoconferencing, should be considered in the context of the condition of the patient and the configuration of the healthcare system. In Australia, like many other countries, diabetes patients are primarily managed by GPs, and the patient is referred to an

**FIG. 2.** Consolidated Standards of Reporting Trials (CONSORT) study flow diagram of the recruitment process. FTF, face-to-face (in-person); VC, videoconference.
endocrinologist when there is a need for a specialist opinion. In such cases, the patient visits an endocrinologist, and the process of care is returned to the referring GP with the management plan. In this arrangement it can be assured that the patient has access to a local GP in case of any potentially dangerous condition due to any flaw in remote consultation of the patient.

Our findings showed that the endocrinologists were more conservative in altering the patients' drugs when consulting via VC, compared with FTF consultation (Table 4). This conservative approach might be due to feeling that the patient is far away and not readily accessible, as would be a local patient, in case of an adverse effect or unforeseen circumstances. The other possible explanation could be lower confidence of doctors on their assessment of the patient's condition when consulting the patient remotely. Nevertheless, in this study we just considered one single consultation for each patient. It is also noteworthy that the doctors in the clinic were not routinely performing video consultation, and essentially it was a new skill for them, so that this might have contributed to the conservative approach. Doctors with

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Reference group (n=37)</th>
<th>Telemedicine group (n=36)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td>0.512</td>
</tr>
<tr>
<td>Female</td>
<td>14 (38%)</td>
<td>11 (31%)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>23 (62%)</td>
<td>25 (69%)</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>59 ± 14</td>
<td>55 ± 14</td>
<td>0.228</td>
</tr>
<tr>
<td>Distance to the clinic</td>
<td></td>
<td></td>
<td>0.254</td>
</tr>
<tr>
<td>&lt;20 km</td>
<td>9 (24%)</td>
<td>15 (42%)</td>
<td></td>
</tr>
<tr>
<td>20–100 km</td>
<td>23 (62%)</td>
<td>16 (44%)</td>
<td></td>
</tr>
<tr>
<td>&gt;100 km</td>
<td>3 (8%)</td>
<td>3 (8%)</td>
<td></td>
</tr>
<tr>
<td>Missing data</td>
<td>2 (6%)</td>
<td>2 (6%)</td>
<td></td>
</tr>
<tr>
<td>Type of diabetes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1DM</td>
<td>11 (30%)</td>
<td>16 (44%)</td>
<td></td>
</tr>
<tr>
<td>T2DM</td>
<td>26 (70%)</td>
<td>20 (56%)</td>
<td></td>
</tr>
<tr>
<td>Diabetes treatment plan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diet only</td>
<td>3 (8%)</td>
<td>1 (3%)</td>
<td>0.768</td>
</tr>
<tr>
<td>OADs only</td>
<td>3 (8%)</td>
<td>2 (6%)</td>
<td></td>
</tr>
<tr>
<td>Insulin only</td>
<td>19 (51%)</td>
<td>23 (64%)</td>
<td></td>
</tr>
<tr>
<td>Insulin + OADs</td>
<td>9 (24%)</td>
<td>8 (22%)</td>
<td></td>
</tr>
<tr>
<td>Data missing</td>
<td>3 (8%)</td>
<td>1 (3%)</td>
<td></td>
</tr>
<tr>
<td>HbA1c (%)</td>
<td>8.3 ± 1.4</td>
<td>8.4 ± 1.7</td>
<td>0.793</td>
</tr>
<tr>
<td>Diabetes complication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retinopathy</td>
<td>13 (35%)</td>
<td>16 (44%)</td>
<td>0.416</td>
</tr>
<tr>
<td>Nephropathy</td>
<td>13 (35%)</td>
<td>12 (33%)</td>
<td>0.871</td>
</tr>
<tr>
<td>Neuropathy</td>
<td>13 (35%)</td>
<td>12 (33%)</td>
<td>0.871</td>
</tr>
<tr>
<td>Ischemic heart disease</td>
<td>11 (30%)</td>
<td>8 (22%)</td>
<td>0.465</td>
</tr>
<tr>
<td>Foot ulcer</td>
<td>1 (3%)</td>
<td>3 (8%)</td>
<td>0.358</td>
</tr>
<tr>
<td>None</td>
<td>13 (35%)</td>
<td>9 (25%)</td>
<td></td>
</tr>
</tbody>
</table>

Variables are summarized as count (%) unless otherwise indicated. *By Pearson χ² test. †Data are mean ± SD values. ‡The percentages do not add up to 100% because of cases with both plans. §By Fisher's exact test. HbA1c, hemoglobin A1c; OAD, oral antidiabetes drugs; T1DM, type 1 diabetes mellitus; T2DM, type 2 diabetes mellitus.

Our findings showed that the endocrinologists were more conservative in altering the patients' drugs when consulting via VC, compared with FTF consultation (Table 4). This conservative approach might be due to feeling that the patient is far away and not readily accessible, as would be a local patient, in case of an adverse effect or unforeseen circumstances. The other possible explanation could be lower confidence of doctors on their assessment of the patient's condition when consulting the patient remotely. Nevertheless, in this study we just considered one single consultation for each patient. It is also noteworthy that the doctors in the clinic were not routinely performing video consultation, and essentially it was a new skill for them, so that this might have contributed to the conservative approach. Doctors with
TABLE 4. Changes in Drugs for the Patients in the Telemedicine Group by the Mode of Consultation

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>Face-to-face</th>
<th>Videoconference</th>
<th>κ (P value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes in antidiabetes drugs</td>
<td>22/36 (61%)</td>
<td>17/36 (47%)</td>
<td>0.316 (P=0.031)</td>
</tr>
<tr>
<td>Changes in cardioprotective drugs</td>
<td>11/36 (31%)</td>
<td>5/36 (14%)</td>
<td>0.368 (P=0.02)</td>
</tr>
<tr>
<td>Overall changes in all drugs</td>
<td>26/36 (72%)</td>
<td>21/36 (58%)</td>
<td>0.235 (P=0.121)</td>
</tr>
</tbody>
</table>

more experience in telemedicine might have had a different approach. It is probable that reluctance to change patient medications in one consultation might be rectified in the following consultations based on the results of laboratory tests. The design of this study did not allow us to test this hypothesis. Nevertheless, research shows practice style of doctors varies remarkably,24,25 and there is anecdotal evidence that the prescribing behavior varies between doctors of the same qualifications in the same discipline; some are more aggressive in changing medications than the others. However, those variations have been evenly distributed between the two groups of this study and expected to have minimal impact in our comparisons.

The actual raw agreement for change in cardiovascular drugs was higher than that of diabetes drugs. This may suggest that altering cardiovascular drugs, on the basis of a blood pressure measurement or lipid profile results, was easier than altering diabetes medications. There might have been fewer adjustments of these medications purely because many patients were actually at target blood pressure or lipid levels. The lower agreement in changing diabetes drugs could be explained by the need of doctors to take more parameters into account, when adjusting patients’ medications. Assessing these parameters, which often include physical activity, diet, home blood glucose level measurements, and compliance to medication regimen, is more subjective.26

There is a trade-off between improved access to health care using information and communication technology–based solutions and the fidelity of the recommendations provided through such encounters.27 However, research shows that overall the patients are satisfied with receiving specialist consultation via telemedicine.28–30 In many situations telemedicine provides the patients with access to care that would not otherwise be possible. For some other situations, it will be the question of timely access to a lower-quality care versus a delayed access to conventional services. Considering the cost and inconvenience of long trips to the cities where specialized care is available, many studies have reported the cost savings as well as the improved accessibility to specialized care for the patients, especially for those who live in remote and rural areas.31,32 It is also noteworthy that for a proportion of people who live in extremely isolated areas, telemedicine is not an alternative to conventional care, but the only option.33

This study has several limitations that should be considered for both interpreting the results and generalizing to other settings and disciplines. First, the doctors in both groups had equal access to the whole patient information, in both electronic and hard copy format. This is not the case in the real world except for the settings in which patients’ information are stored and retrieved electronically and fully accessible from a distance. Second, the research endocrinologist, who conducted the first consultation for all the patients, neither managed the patient nor was responsible for the consequences of the recommendations that she made for the purpose of this research. A more robust design would constitute a situation in which both doctors would take the case of any patient equally seriously. However, we assume this condition equally affected both groups and thus had no effect on the ultimate comparison between the telemedicine and reference groups. Also, the imbalance of type of diabetes between the two groups may have possibly influenced the results. Another limitation of the study is that it did not assess the possible importance of FTF counseling and motivational interview techniques to alter patients’ self-management, nor did the study assess longer-term clinical outcomes such as hemoglobin A1c, and we have assumed the change in medications is an important outcome that will affect patient outcomes. In an ideal situation, clinical outcomes should be assessed in the long term (i.e., a randomized controlled trial comparing a group over 12 months who are managed via FTF vs. telemedicine).

In this pilot trial we studied the intervention in a single consultation for each participant, whereas the process of care for the people with diabetes is ongoing and often lifelong. Consultation with a specialist often requires several consecutive consultations. It is expected that even if the fidelity of care delivered via VC is suboptimal in the first encounter compared with FTF, it will be addressed in the follow-up consultations in the light of laboratory test results. Future studies should consider the whole process of care by the specialist, comprising several consultations over a longer period of time, similar to what patients receive in the real world.

Appropriately powered clinical trials are needed to confirm the findings of this study on the validity of videoconferencing for specialist remote consultation of diabetes. There is a need for developing reliable indicators for assessing the impact of the medium of communication on the outcome of office visits to adequately inform the design of health services research, especially for evaluating telemedicine interventions.

Conclusions

This study presents preliminary evidence on the validity of remote consultation using real-time videoconferencing for specialty consultation for people with diabetes by endocrinologists. Endocrinologists who provided a consultation to the patients remotely using videoconferencing were more conservative than those who consulted FTF in changing the antidiabetes drugs, but not for cardiovascular drugs. Further studies are needed to confirm these findings and to assess the clinical outcomes of video consultation in the long term.
Acknowledgments

This study was supported by Queensland Health and the Centre for Online Health, The University of Queensland, Australia. QIMR Berghofer Medical Research Institute gratefully acknowledges infrastructure research support from the Australian Government’s National Collaborative Research Initiative Strategy initiative through Therapeutic Innovation Australia. The authors thank Dr. Christina Jang, Dr. Grant Cracknell, Dr. Ross Cuneo, Dr. Warrick lnder, Dr. Judy Hadwen, Dr. Emily Mackenzie, Dr. Clair Sullivan, and Dr. Viral Chikani for their kind cooperation. We are grateful to Dr. Melinda Martin-Khan, Ms. Christine Sheehan, the staff at the Princess Alexandra Hospital diabetes clinic, and the people who agreed to participate in this study.

Author Disclosure Statement

No competing financial interests exist.

F.F. collected and researched data and wrote the manuscript. L.C.G. and A.W.R. designed the study, contributed to the discussion, and edited the manuscript. S.K.P. contributed to the statistical analysis, contributed to the Results and Discussion, and edited the manuscript. F.F. is the sole guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data.

References


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