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Effect of Telediagnosis on Health Outcomes of Diabetic Patients in Nairobi County, Kenya

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Abstract: *Diabetes has become a significant public health concern worldwide, calling for telemedicine interventions to mitigate this health problem. It is on this basis that health facilities are adopting telediagnosis intervention as an alternative to improved health outcomes. Telediagnosis is the process of using software, sensors, and communication devices to monitor, analyze, and diagnose. This study sought to examine the effect of telediagnosis on health outcomes of diabetic patients in Nairobi County, Kenya. This study was guided by self-determination theory. The study employed a descriptive design and targeted diabetic patients in Nairobi City County. Key informants recruited through purposive sampling and systematic simple random sampling was used to collect data through self-administered questionnaires and interviews. Two focus group discussions were conducted. Statistical analysis was done by use of Statistical Package for Social Sciences (SPSS) version 24.1 and by generating descriptive analyses. For the qualitative data, the researchers used recurring patterns to form topics. One of the major findings revealed that the majority, (43.9%) of the respondents indicated that telediagnosis was very good. This means mobile device connectivity for telediagnosis in Nairobi was reliable and should be encouraged for purposes of Mobile health services (mhealth) services, thus saving on time and resources that would have otherwise been used in making physical visits to healthcare facilities. The study recommends that the government partner with facilities and other stakeholders to create awareness of the availability of telehealth services.*

Keywords: *Tele-diagnosis, Health outcomes, Diabetes, Patients, Nairobi County*

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1. Introduction

Telediagnosis is the process of using software, sensors, and communication devices to monitor, analyze, and diagnose. Smith, Hunte and Graber, (2020), define telediagnosis as the co-production of an accurate and timely explanation of the patient's health problem through remote interactions and transmitted data, and a clear explanation to the patient through these interactions. It can also be said to be a medical diagnosis made by means of telemedicine. Telemedicine is defined by World Health Organization (WHO) as the delivery of health care services, where distance is a critical factor, by all health care professionals (HCP) using information and communication technologies for the exchange of valid information for the diagnosis, treatment, and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of progressing the health of individuals and their communities (Ghosh, Gupta & Misra, 2020). On the other hand, (Pradeepa, Rajalakshmi & Mohan, 2019) define telemedicine as the remote exchange of medical information or services through

electronic communication technologies between patients and clinicians. Telemedicine is increasingly used to improve access to health care and clinical outcomes not only for diabetics but also for other ailments. As most of the aspects of life have become automated and addressed online, so will routine medical care for chronic diseases (Borries et al., 2019).

Diabetes has become a significant public health concern worldwide. It is one of the most prevalent chronic and preventable conditions affecting over 415 million people globally, and accounted for over 5 million deaths in 2015 (Ogurtsova et al. 2017), and 4 million in 2017, indicating one death every 8 seconds (Shukri et al. 2018). It is estimated to have become the seventh leading cause of death in the USA, Wang et al (2019). Low-income countries are expected to experience the highest increase in diabetes prevalence (92%) as opposed to higher-income countries with (25%) WHO, (2016). Undiagnosed diabetes poses a public health concern with costly public health implications, especially in Africa. Studies also indicate that by 2040, low-income countries are projected to experience a 92% increase in mortality due to diabetes, Shukri et al., (2018). In Kenya, the prevalence of diabetes stands at 3.3% with 59% being female whose mean age was 58 years and, by 2025 it will rise to 4.5 % Tambo, (2021). People with diabetes, specifically those with poor *glycemic* control, have been identified as a risk cohort that needs to be particularly protected from infectious diseases (Singh & Misra 2020). This is a challenge to most diabetic patients because access to endocrinologists is limited, especially in rural and remote areas.

According to Badri & Hamdy (2021), about 85% of diabetes care is carried out by non-endocrinologists, like primary care physicians whose estimated shortage by 2030 will be 14,800-49,300. It is important to mention that current diabetes guidelines recommend diabetologist or general practitioner consultations at least every 3 months to measure Hemoglobin A1C (HbA1c) presentations and exams in the outpatient setting are therefore required to optimize diabetes control and also effectively treat related comorbidities. The ripple effect of the growing number of diabetic patients has led to high costs of treatment and physicians who are overworked leading to reduced doctor-patient interaction time. It is however important to examine, whether or not, individuals with diabetes, necessarily need to regularly present themselves physically at outpatient clinics or doctors' offices, especially when alternative services (i.e. telemedicine) that can guide disease management are available. Because there is a need to improve access to diabetes care management for patients, a new model of diabetic care is essential. Technological evolutions of digital health like telemedicine are promising better healthcare for diabetic patients' future.

Recent advances in information technology and the widespread availability of mobile phones present unique opportunities for the prevention, control, and management of chronic diseases like diabetes (Siminerio, 2010). These approaches include telemedicine, mobile technology, and the use of the Internet. However, there is a need for developing comprehensive interventions and integrating available technologies to be able to provide comprehensive care for diabetes. Healthy People, 2020, a US-based group, for example, promotes the improvement of the health of diabetic patients and others using telemedicine with the aim of helping them attain high quality longer lives, and live free of preventable diseases, disability injury, and premature death, ultimately achieving health equity. Through telemedicine, patients will be involved in their own diabetes management and achieve better glycemic control while maintaining patient-provider communication, (Badri & Hamdy, 2021). Equitable telemedicine requires reliable, accessible, and affordable internet and digital literacy (Siefer, 2021). Kenyan Vision 2030 seeks to have Universal Health Care by 2030 for a more prosperous and healthier country. To achieve this, and SDG 3 (good health and well-being for all), the current healthcare system must embrace telemedicine technology in order to safeguard the advancement of enhanced patient outcomes, cost, and quality of life, Dinesen et al., (2016). The primary solution to the increased utilization of telemedicine applications will be supported by strong research-based evidence that telehealth applications are both sustainable and scalable (Dinesen et al., 2016).

2. Literature Review

As governmental priorities continue to emphasize patient involvement in the management of their disease, there is an increasing need to accurately capture the provider–patient interactions in clinical encounters. Telediagnosis is the process of using software, sensors, and communication devices to monitor, analyze, and diagnose. Smith, Hunte, Graber, (2020), define telediagnosis as the co-production of an accurate and timely explanation of the patient's health problem through remote interactions and transmitted data, and a clear explanation to the patient through these interactions. It can also be said to be a medical diagnosis made by means of telemedicine. Patient-centered models of care focusing on patient autonomy, informed consent, and empowerment have gained a high level of policy support (John et al., 2021). According to Keinfenheim et al. (2015), a great deal can be learned from a simple conversation and review of medical records online.

A successful diagnosis involves teamwork, but the composition will depend on the needs of the patient. Ideally, it may consist of the patient, his/her family, and all healthcare professionals involved in his/her care

(Henriksen and Brady, 2013; McDonald, Bryce, and Graber, 2013; Babiker *et al*., 2014; Graedon and Graedon, 2014). Teams may be complex in nature and may be composed of people with different knowledge and skills, from different backgrounds and at different geographical locations. Some members of the team can be out of the healthcare facility for training, workshops, and conferences. It may not be economical or feasible for a healthcare facility to employ all categories of healthcare professionals; it may be necessary to consult with experts located in other facilities. The team needs to communicate. The members of the team need to be on the same page with regard to the patient's vital signs, records, and other relevant pieces of information that are required for diagnosis. Such healthcare professionals are doctors, nurses, medical assistants, radiologists, technologists, laboratory scientists, pharmacists, patient navigators, social workers, therapists, nutritionists, biomedical engineers, and biomedical technologists.

Diagnosis involves information gathering, review, analysis, interpretation, narrowing down the diagnostic possibilities, and developing an accurate understanding of the patient's health problem. It is the traditional basis for decision-making in clinical practice (Croft et al., 2015). Real-time telemedicine, for example, is a promising strategy for improving access to care and care delivery in image-oriented fields like ophthalmology and radiology, where diagnostic decisions are often based on the review of photographs/images that are captured by trained technicians, (Dasgupta, 2008). Traditional methods of chronic disease management use rule engines or score estimations for diabetes risk identification, which are not as effective as machine learning techniques in detecting patient health conditions (Bruen et al. 2017).

Recent developments in machine learning and feature engineering, present new possibilities to improve early diagnosis and treatment outcomes of chronic diabetes patients like the use of virtual diagnostician coaching (Onan, 2019). The ability to communicate effectively during telehealth interactions is a core competency for clinicians. Studies suggest that clinicians should draw on similar communication skills for telehealth visits to those used when they are face-to-face with their patients Pappas et al. (2019). These skills include deep and reflective listening, motivational interviewing, and critical nonverbal communication attributes, such as eye contact. Many clinicians already struggle with fostering presence and connection with patients during clinic visits (Kesavadev et al., 2015).

Creating a presence during telediagnosis visits requires that clinicians adopt additional skills to effectively develop relationships, engender patients' trust, and avoid depersonalization of the remote encounter. Many healthcare organizations have developed orientation training for their clinicians new to virtual encounters, and publications with tips and advice are widely available to optimize (Kvedar 2020). While some of the skills needed for a successful telehealth visit are similar to those needed for an effective in-person visit, additional skills include how to prepare for the encounter, what to wear, how to adjust the lighting and background, how to summarize the visit, and the need to outline and confirm patient's understanding of next steps Zulman DM, et al. (2020). Bhaskar, Nurtazina, Mittoo, Banach, and Weissert (2021), observed that mobile devices for telemedicine became prominent during Covid-19 as patients could easily engage with their healthcare providers for consultations and medical prescriptions.

Some of the devices used for telediagnosis include tele-ultrasound, a robotic system based on ultrasound. It captures and stores images as audio texts, Picker's remote diagnostic tool for CT scanners also known as "Expert" enables step-by-step diagnostic routines, and teleradiology that interprets medical images that are far from physical location. Examples of devices that are used for diagnosis in developed countries include interfacing biomedical diagnostic devices with the Internet of Things (IoT) which enhances Telediagnosis by allowing electrodes to convert the heart signal to an electrical signal known as Electrocardiogram (ECG). The ECG signal is sampled and processed using a microcontroller. The microcontroller interfaces the ECG signal with a Wi-Fi shield which is an Internet of Things (IoT) device. The IoT shield is responsible for deploring the ECG signals onto the web for further analysis. ThingSpeak on the other hand is a web-based platform that collects the signal and performs a real-time plot over the internet. The patient's vital signs are available anywhere across the globe by accessing the ThingSpeak platform. The Wi-Fi shield is immune to external attack and only the network administrator and other authorized personnel can have access to the medical records. Healthcare team members can be updated with the required information on the patient thereby enabling Telediagnosis. The system can be expanded to include more biomedical devices, more vital signs, and more patients. Deploring this technology in African hospitals by African Engineers is found to be feasible and economical. It would improve the African healthcare delivery system.

Kenya now has BYON8, a digital diagnostic application, originally founded in Sweden and introduced by a doctor, Murad in 2021 operating according to Safaricom online, (16/11/ 2022). It has over 40,000 active users. The application transforms a patient's data into diagnosis propositions. The gadget has a symptom checker that provides a list of possible causes of ailment. This is followed by online interaction with the doctor who then gives prescription and treatment. The application also

books appointments with licensed doctors, allows chats and video calls with the doctor, and keeps track of the patient's health information, lab reports, and healthcare visits, among other things (monitoring). To use it, one needs to download the BYON 8 app, register, and even subscribe then pay using Mpesa.

The steps of the diagnostic process are comparable in telediagnosis and in-person assessments. However, though telediagnosis presents unique challenges for providers and patients, it creates opportunities for improvement in the process. Telediagnosis not only requires specialized training but also a new language for patients to describe their symptoms and unique communication skills. According to the Agency for Healthcare Research and Quality (2020), telemedicine experts acknowledge the challenges of visualizing some parts of the body as well as listening to the heart and lungs. They, however, maintain that every other element of the examination can be performed successfully with a trained clinician and a willing patient. Similar to in-person interactions, the clinician-patient relationship and the level of patient involvement can influence the effectiveness and quality of the telehealth encounter (Pappas, et al., 2019). With proper preparation, providers say that a telediagnosis visit is as good as a physical visit (Kvedar, 2020).

Research suggests that if the patient does not have a previous relationship with the clinician, video visits are preferred and provide a more natural setting to establish clinician presence and effective patient engagement Kvedar, 2020). Clinicians may be more comfortable with telephone visits for their established patients. Patient engagement and participation in telediagnosis has been ignored over time, and there needs to be ways of involving them. Martinez, et al. (2020). Telediagnosis services that only focus on access issues and ignore how individuals in vulnerable populations process and understand the information shared may exacerbate existing health disparities, Parker et al. (2020). The efficacy of telediagnosis for acute conditions has yet to be validated. With the tools and functionality of telehealth evolving so rapidly, formal controlled studies will be a challenge. New research will need to be highly focused, iterative, and adaptive to the unique aspects of care provided remotely Van et al. (2020).

Existing research regarding diagnostic accuracy in telemedicine has focused primarily on teledermatology or specific clinical contexts (e.g., stroke identification) according to Solenski, (2018), Trettel (2018 & Bashur, 2017). Telediagnosis is unprecedented, creating more unknowns on diagnostic impact, quality, and safety as indicated by Willis (2021) & Smith (2020). Published evidence regarding the effectiveness of telediagnosis is fairly limited and mixed, (Shigekawa, Totten & Mold, 2018). A 2021 survey by (SIDM) on the diagnosis experience of patients and clinicians, reported by McConnochie, 2015, shows high patient satisfaction but at a cost. A 2020 Mayo Clinic study on the Assessment of Clinician Diagnostic Concordance with Video Telemedicine in the Integrated Multispecialty Practice findings on the other hand indicated that there were some cases identified in the primary-care telemedicine program that resulted in morbidity and mortality that might have been mitigated by an initial in-person visit. However, Ohta et al. (2017) reported that telemedicine can provide the same or similar level of diagnostic concordance as face-to-face practice. However, Tachakra, Lynch, Newson, Stinson, Sivakumar, Hayes, and Bak (2000), argues that telemedicine diagnosis is as good as face to face diagnosis.

Self-determination theory

Self-Determination Theory **(**SDT**)** was advanced by Deci & Ryan (1985). The theory suggests that individuals are growth-oriented organisms who actively interact with their environment Deci & Ryan, (2000). SDT, according to Ryan & Deci (2000), is a metatheory of human motivation and personality development. It is a widely applied theory of motivation, personality development, and wellness. SDT underlines that individuals could be proactive or passive, according to the social conditions in which they are involved. Self-motivation could be fostered or inhibited by different situations.

The theory suggests that while people are often motivated to act by external rewards such as money, prizes and acclaim (extrinsic motivation), self-determination theory focuses primarily on internal sources of motivation such as a need to gain knowledge or independence (intrinsic motivation). The theory argues that Autonomous motivation (intrinsic) tends to produce greater psychological health and more effective performance compared to Controlled motivation (extrinsic). The theory suggests that people are able to become self-determined when their needs for competence, connection, and autonomy are fulfilled. In this study, the patient who strives to utilize telemedicine becomes familiar with requirements and devices and as they begin to discover the advantages, they develop a paradigm shift i.e. from FTF to telemedicine. It is thought of as a metatheory in the sense that it is made up of several "mini-theories", *cognitive evaluation, organismic integration, causality orientation, basic psychological need, goal content, and relationship motivation* which fuse together to offer a comprehensive understanding of human motivation and functioning including work, (Fernet, 2013), relationships (Guardia & Patrick 2008), education (Reeve & Lee, 2014), religion (Soenens et al. 2012), sports (Pelletier et al. 2001), and even stereotyping and prejudice (Legault et al. 2007).

A study by Migliorini, Cardinali & Nadia, (2019) found

that autonomy support, perceived competence, and autonomous motivation, which are core elements in SDT, were determinants of diabetes self-management and well-being. The autonomous support from healthcare professionals for patients with Type 2 diabetes (T2D) was found to improve diabetes management thereby improving blood glucose control. The study findings also indicated that SDT is valued as a conceptual framework to study motivational processes and helps patients adopt and maintain new health behaviors.

3. Methodology

The study employed a descriptive design. It used a systematic sampling method to collect the required data. Self-administered questionnaires, which contained items that are, both open and closed-ended. There were two Focus Group Discussions. The data collected was used to illustrate the effect of telemedicine utilization on the health outcomes of diabetic patients. The study participants represent diabetic users of telemedicine**,** diagnosis treatment, information or advice, or follow-ups and the healthcare providers/professionals who provide these services. Targeted participants were required to at least have access to a mobile phone. The study targeted 71 respondents out of which 14 were key informants from all the targeted health facilities 2 focus group discussions, one from a private hospital and another from a public hospital was also held. This was to establish whether public hospitals offer equally competitive services like private, as such the average citizen in need of telemedicine does not miss out on the services. The researcher talked to individual diabetic patients who were willing to take part in the study. Snowballing was also used to locate diabetic patients within Nairobi County. Data for this study was analysed both quantitatively and qualitatively. Graphical analysis and descriptive statistics form the basis of virtually every form of quantitative analysis. The study accomplished its statistical analysis by using the standard statistical program SPSS, and by running simple descriptive analyses to obtain reports on data status and final results. For the qualitative data, the researcher used recurring patterns to form topics. The data was presented along emerging themes.

4. Result and Discussions

4.1 Telediagnosis and Health Outcomes

The objective of the study was to assess the impact of telediagnosis on health outcomes of diabetic patients through experiences with caregivers. The researchers started by finding out the reception from caregivers on the use of remote diagnostic and treatment. The results are presented in table 1 below.

Table 1: Reception from Caregivers during Telediagnosis

	Frequency	Percent
Below average	11	19.3
Fair	12	21.1
Good	5	8.8
very good	25	43.9
Excellent	4	7.0
Total	57	100.0

Source: (Researcher, 2023)

The study showed that 25 (43.9%) of the respondents indicated it was very good, 11 (19.3%) of the respondents indicated it was below average, 12 (21.1%) of the respondents indicated it was fair, 5 (8.8%) of the respondents indicated it was good, while 4 (7.0%) of the respondents indicated it was excellent. This means mobile device connectivity for telediagnosis in Nairobi is reliable and should be encouraged for purposes of Mobile health services (mhealth) services. Also, given the reliability of the connectivity with mhealth devices, it can be said that telemedicine services tend to save time and resources that would have otherwise been used in making physical visits to healthcare facilities.

4.2 Ascertaining How Patients Engaged with Doctors

The study also sought to assess how easy it was to talk with the doctor, i.e., rapport during remote diagnosis. Statistical results are presented in Table. 2 below.

Table 2: The Level of Ease When Engaging with the Doctor

Level of ease when engaging with the doctor	Frequency	Percent
Fair	3	5.3
Good	9	15.8
very good	32	56.1
Excellent	13	22.8
Total	57	100.0

Source: (Researcher, 2023)

The study showed that majority of the respondents, 32 (56.1%) indicated that rapport was very good, 13 (22.8%) of the respondents indicated it was excellent, 9 (15.8%) of the respondents indicated it was good, while 3 (5.3%) of the respondents indicated it was fair indicating majority of the respondents had a good relationship with their doctors/providers. This study therefore concurs with a study by Bhaskar, Nurtazina, Mittoo, Banach, and Weissert (2021), which observes that mobile devices for telemedicine became prominent during Covid-19 as patients could easily engage with their healthcare providers for consultations and medical prescriptions.

4.3 Reliability of the Device Used

The study sought to assess the reliability of the device used during remote telediagnosis. The results are presented in Table below.

Table 3: Reliability of the Device Used

Reliability of the device used	Frequency	Percent
Fair	5	8.8
Good	10	17.5
very good	25	43.9
Excellent	17	29.8
Total	57	100.0

Source (Researcher 2023)

Statistical results show that 25 (43.9%) of the respondents indicated their device's reliability was very good, 17 (29.8%) of the respondents indicated it was excellent, 10 (17.5%) of them thought it was good, while 5 (8.8%) of the respondents indicated it was fair. Responses from the key informants indicated each facility had a unique way of ensuring patients receive the correct remote diagnosis ranging from patients sending prior brief reports, asking specific questions related to the symptoms, and asking for lab reviews among other measures. As narrated by a key informant: *"Patients are required to have a physical visit in addition to the remote one," said the* F1 informant.

At F2, the client is required to remotely send a brief report on his/her signs /symptoms before they are booked for a consultation. In the event that the doctor is uncomfortable making a diagnosis or needs to examine the patient, then we ask the client to come to the facility. According to the F3 informant, doctors ask the client a series of target questions to determine the symptoms during a video consultation, while at F5, the doctor must inquire from the patient if they have done a laboratory review such as Home-Based Medical Care (HBMC), Lipid profile and the likely shortcomings singled out were the possibility of data breaches raised by the Fl informant and the inability to source vital signs, according to F2 informant, where a diagnosis is only based on the client's verbalization.

One of the key informants asserted that:

> *When we receive calls, we try to ask specific questions relating to how the patients are feeling based on their symptoms…It is not possible to source vital signs remotely, since diagnosis is only based on the client's verbalization. Non-verbal communication may not be well interpreted at times, D5 informant.*

Findings from the FGD groups above it is evident that the discussants had varying and similar experiences with diabetes. They were not aware at the initial stages of their ailments that they were experiencing symptoms of diabetes until they went for check-ups, with some going for remote consultations with their doctors who suspected diabetes. All had FTF diagnoses for the first time.

> *I realized I had a problem when I started urinating frequently, but I didn't know the cause. I booked an appointment and later went to the hospital and on being checked up, I was found to*

> *be having diabetes. This shocked me as I never imagined I would suffer anything like this", said PR2 who has had diabetes for over 10 years.*

The participant however, confirmed that she had adjusted to the new diet and lifestyle. These same symptoms were shared by PR1 who narrated that *"I realized I was losing weight though I never felt any pain in my body. I went to the hospital and on being checked, my sugar level was 30.! The normal level is usually between 4-6,"* said the 66-year-old man.

PR2 from group 2 who has some of the check-up devices reiterated her concerns over their high cost and lack of usage know-how.

> *Devices for checkups or diagnosis are quite expensive and complicated to use. Minus advice on how to apply them, one may just feel the need for a proper physical diagnosis which cannot happen remotely yet in our country. An incorrect diagnosis can lead to a wrong prescription. Sometimes when you want to engage the doctor, he or she may be unavailable online. **S**he concluded.*

PR1, while agreeing with her sentiments said there is little or no education or advice on how to use tele-diagnosis devices thus, more information is needed especially among the elderly. He said frequent power failures also affect internet access and that at times the internet connection is unstable. PR6 however, felt that even though telediagnosis may be looking attractive, there was need for physical examination once in a while.

A PR participant narrated that:

> *From my experience, some side effects need a physical examination. I used to have a skin infection that was related to my diabetic condition, this might not be well captured remotely. If a physical examination is done, the doctor will prescribe the correct drugs, so physical presence is good. PR6*

She added that at one time when she went for her appointment, her doctor noticed by looking at her that the blood level was low. When a test was done, it was confirmed so fears, it was 7 as opposed to 12, which was the normal level. These findings differ with a study conducted by Tachakra, Lynch, Newson, Stinson, Sivakumar, Hayes, and Bak (2000), which argues that telemedicine diagnosis is as good as face to face diagnosis.

5. Conclusion and Recommendations

5.1 Conclusion

The study came up with the conclusion that though it is easy to consult a healthcare provider when the need arises, it can be difficult to consult the same healthcare provider or any other during pandemics like COVID-19. Almost 100% of the patients are at ease consulting with the health providers and have a good feeling about it. Regarding relationship between tele-advice and health outcomes among diabetic patients, the study concluded that more information, especially on exercise and adherence is needed.

5.2 Recommendations

Based on the findings from the study:

1. There is a need for the introduction and improvement of telehealth services in all facilities, especially public hospitals, to allow health equity to prevail in order to achieve Universal Health Care (UHC).
2. The government partner with facilities and other stakeholders to create awareness of the availability of telehealth services.

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