

The Role of Digital Technologies for Effective Self-Management in Patients with Diabetes during COVID-19 Pandemic

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Abstract:- The purpose of this study is to evaluate the need and describe the potential role of globally utilized digital technologies in the effective treatment of diabetes in the country of Georgia. The overall objective was to identify means to respond to challenges in developing countries with regard to a dearth of easily accessible knowledge about the disease, its complications, and the need for self-care and to overcome problems of limited geographical and financial accessibility to medical services aggravated during the Covid-19 pandemic.

A combination of mixed-research methods has been applied. Initially, a narrative literature review was performed. At the second stage, qualitative study - in-depth interviews with stakeholders were conducted. At the third stage, quantitative research was performed. More specifically, an online survey of adult patients - having diabetes, as well as, an online survey of parents whose children have diabetes, was conducted.

Based upon the results, one of the possible solutions in addressing existing problems in Georgia and other developing countries with regard to patient education and self-management is to leverage digital technologies. The overall implication of the electronic platform is to increase awareness and education in patients and parents of children with diabetes, as well as, to improve communication between doctors and patients alike.

Consequently, this can help to alleviate some of the everyday concerns of patients, and to increase their motivation, thus enabling them to carry on a higher standard and quality of life.

I. INTRODUCTION

The effective management of diabetes and its complications is one of the most important and challenging missions of the governments of various countries. It represents significant socio-economic problems in the world. According to the World Health Organization (WHO), there was a 5 percent increase in premature mortality from diabetes between 2000 and 2016 (1). Moreover, it is a major cause of strokes, heart attacks, kidney failure, blindness, and lower-limb amputations (2). It is well-known that diabetes is a chronic condition that requires continuous and consistent self-management. With proper diet, physical activity,

medication, regular screening, and prevention its consequences can be avoided or delayed (3, 4).

As the evidence demonstrates, the prevalence of diabetes has been increasing at a greater pace in low and middle-income countries compared to high-income countries (5, 6). Eighty percent (80%) of all diabetic patients worldwide live in developing countries (7). The burden of diabetes on developing countries is further aggravated by the fact that diabetic patients in developing countries are less informed (educated) about their disease and its complications and are less adherent (8). Even though the self-management of diabetes is crucial for minimizing the risk of complications, it is widely recognized, patients in low and middle-income countries often lack adequate knowledge about the importance of self-care, behavior change, and therapeutic education (9).

Another problem for insufficient levels of self-management in diabetic patients living in developing countries can be limited access to high-quality specialists (10), as well as to medical services, including prevention and screening of complications (11). The Covid-19 pandemic caught countries unprepared and exposed gaps in their healthcare systems. In response to the COVID-19 pandemic, governments in many countries have restricted the mobility of their citizens, imposing strict “lock-downs” and confining citizens to the home environment. Consequently, accessibility to medical services was limited for patients, and stress and physical inactivity increased risks of obesity, hyperglycemia, and diabetes-related complications (12). According to WHO, management of diabetes, as well as other non-communicable diseases, has worsened significantly. To illustrate, the Covid-19 pandemic management of diabetes and its complications decreased by 49% worldwide, “with lower-middle-income countries being somewhat more likely to report disruptions to these services”. This is when the role of digital health technologies became accentuated as an alternative solution for increasing access to medical services. For instance, in the WHO survey, mentioned earlier, 58% of the countries demonstrated utilization of telemedicine to replace face-to-face consultations in times of pandemics. Moreover, 40% of low-income countries and 50% of lower-middle-income countries participating in the survey had adopted teleconsultation as an alternative channel for the management of non-communicable diseases (13). Digital health has been seen as an emerging, strategic health priority

for years. Even before the COVID-19 pandemic, the need for digital health technologies to bring health systems and services to a higher level of effectiveness was widely recognized by experts. To illustrate, digital technologies utilized for the management of diabetes, telemedicine, store-and-forward approach, mobile applications, and online platforms have been used successfully for patient education, coaching, and monitoring behavior change (14, 15, and 16). Furthermore, with the integration of daily reports of continuous glucose monitoring data, as well as other test results, in electronic medical records, an opportunity is provided for the doctors to observe changes in patient behavior more thoroughly, to assess the effectiveness of prescribed medicines and to adjust treatment approaches more flexibly (17,18).

The presented research is focused on Georgia as a case study which gives a snapshot of a developing country, with an adult patient caseload of 300,000 (according to WHO estimates) and 1,200 children having diabetes. This country faces significant problems and challenges in terms of diabetes management. The presented research sought to assess the need and role of globally utilized digital technologies for the effective treatment of diabetes in Georgia. The main research question was formulated as – **“Which digital health technologies can be applied in Georgia for the effective management of type 1 and type 2 diabetes?”** Consequently, the goals of the research were: to identify major problems and challenges related to diabetes management in Georgia; to evaluate digital health technologies utilized globally for effective management of diabetes; to assess feasibility for implementation of selected digital technologies and, the range of stakeholder attitudes towards it.

II. METHODOLOGY

A mixed-method research approach was applied to best achieve the research objectives. It started with a detailed Literature Review and was focused on digital health technologies employed for diabetes management in other countries. For this reason, HINARI, IOM, NCBI, PubMed, Google Scholar, and Elsevier scientific article bases were used. A total of 160 articles were identified and 60 were considered to be relevant for inclusion.

In keeping with the research goals, during the second stage, qualitative study - in-depth interviews with various stakeholders were conducted. The target group of respondents for interviews consisted of endocrinologists, patients having diabetes, parents of children with type 1 diabetes, and experts of the field, from various regions of Georgia. A total of 20 in-depth interviews were conducted, four interviews were face-to-face and 16 by phone and video calls. The average duration of an interview was 50 minutes. Upon the collection of adequate data, interviews with the specific stakeholder group were ceased. Based upon informed consent; the interviews were then transcribed and analyzed using N-Vivo software.

At the third stage of the research, a quantitative study was performed. More specifically, an online survey of adult patients - having type 1 or type 2 diabetes - was conducted, using a structured questionnaire. It should be noted that the precise number of diabetic patients in Georgia is not identified. According to the WHO estimation, based on the extrapolation of Turkey's data, there should be 300,000 adult patients with diabetes in Georgia. Consequently, the sample size was calculated with consideration of this number and was determined as 196 adult patients (Confidence level-95%, Margin of Error-7%). Furthermore, within the scope of quantitative research, an online survey of parents of the children with type 1 diabetes was conducted as well (to assess specific problems in the parent community), using a structured questionnaire. Since the total population of children with diabetes in Georgia is 1,200, the sample size was determined to be 174 respondents (Confidence level-95%, Margin of Error-7%). A total of 200 adult patients and 175 parents were surveyed.

Researchers were enrolled in closed Facebook groups – one uniting adult patients with diabetes and another group of parents of children having type 1 diabetes, in keeping with the research objectives. A researcher observed every post and comment in both groups, over a period of four months, so to effectively evaluate the most frequently asked questions, topics of interest, problems, and the needs of patients. Both questionnaires were created based on various available survey instruments, findings of in-depth interviews, and results of observation in social networks. Before conducting the survey, both instruments were reviewed by several experts, pilot-tested on five respondents each, and adapted accordingly. A questionnaire for adult patients was distributed in a closed Facebook group uniting patients with diabetes and another one – in the group of parents of the children having type 1 diabetes. Consequently, results were analyzed using SPSS software.

At the final stage of the research, four repeat in-depth interviews were conducted (4 respondents were selected from 20 interviewees) to evaluate quantitative study findings in more detail. Accordingly, recommendations were elaborated.

III. RESULTS

During the literature review, various studies, meta-analyses, and systematic reviews were evaluated on the topic of digital technology utilization in diabetes management. In particular, the effectiveness of telemedicine, in the form of virtual consultations and store-and-forward approaches, for improving diabetes self-management in patients was assessed. Moreover, the usefulness of continuous glucose monitoring, fresh glucose monitoring devices, insulin pump, and closed-loop systems for improving maintenance of euglycemia was evaluated. Furthermore, the effectiveness of M-health (mobile health) and online platforms, as well as, various applications for patient education, for better access to medical services and improving self-care was studied. As a result of the literature review, an online application/platform was identified as

potentially feasible to implement and very useful for the education of patients with diabetes and the parents of those children with type 1 diabetes. The electronic platform can be effectively employed as means of increasing the qualification of doctors in the regions. Even more, it can assist in the implementation of a multidisciplinary team approach in the treatment of diabetes by the inclusion of virtual consultations of nutritionists, psychologists, and other deficient specialists. Consequently, these ideas were used in interviews and surveys of the research, to assess the feasibility and attitudes of stakeholders.

The purpose of in-depth interviews was to evaluate major problems patients with diabetes experience in Georgia, in terms of self-care, management of the disease, and the prevention of complications. Another goal was to study the opinions of various stakeholders concerning digital technology adoption for better management of diabetes and its complications and for solving existing problems. The findings of in-depth interviews, demonstrated that one of the major problems for diabetes self-management, in Georgia, was a lack of knowledge and therapeutic education among patients having diabetes and parents of the children with type 1 diabetes.

Listed among the identified reasons include the absence of diabetic schools for adult patients, doctors not having enough time for patient education, and scarcity of accessible updated information about the disease in the native language. To illustrate things better, diabetes schools financed by the government are only present in pediatric hospitals and are focused on educating parents. Nevertheless, according to the parents and endocrinologists, the effectiveness of this course of instruction is low, since it is only offered during the stay in the hospital when a child is first diagnosed to have diabetes. Consequently, due to high-stress levels in parents, uptake of the information is limited at best.

During interviews, healthcare specialists emphasized the importance of adequate communication with patients. To quote one of the respondents, an endocrinologist: “you should remind a patient during every visit, why self-care is important, how terrible complications of diabetes can be and what can be the threats of not complying with the diet. It should be repeated every single time”. However, with consideration of a standard 15-minute time interval that specialists normally have for each consultation, it is difficult for endocrinologists to educate a patient. In addition, since the primary healthcare system is weak in Georgia and the multidisciplinary team approach is not adopted in the clinics, endocrinologists often have to combine the roles of nutritionist and psychologist.

One more reason for low levels of patient education is the shortage and low qualification of nurses in the primary healthcare system (whose main responsibility is to educate patients). According to NCDC, there are only 0,3 nurses per physician at the PHC level (National Center for Disease Control and Public Health, Statistical Yearbook, 2018).

Assessment of existing situations concerning digital technologies for diabetes management reveals that continuous glucose monitoring devices are most adopted by the patients, in Georgia, compared to insulin pumps and other technologies. Major barriers hindering the broader utilization of glucose monitoring devices are relatively expensive price and there is a shortage of them in their country of residence. It should be emphasized, that the majority of interviewed endocrinologists lack knowledge and do not have the expertise of using insulin pumps and other technologies that are not adopted widely in the country.

Another significant problem for the management of diabetes and its complications is limited geographic and financial accessibility to medical services and specialists. In particular, according to the respondents, there are regions and towns in Georgia without children’s endocrinologists and other qualified specialists. Due to these reasons, patients have to travel to the capital of Georgia or other big cities for preventive check-ups and monitoring complications of diabetes. This, in turn, is related to additional expenditures and represents a barrier to the effective management of diabetes and its complications.

As the results of the interviews demonstrated, another significant barrier for self-management is a lack of motivation in adult patients with diabetes. Even though interviewed endocrinologists realize the importance of patient motivation for behavior change and self-care, they lack the qualification and skills to fill this gap. This is especially important in the case of children having diabetes, especially where there is a need for a psychologist’s involvement in the treatment and management of the disease is crucial. It should be noted here, that for children with diabetes, additional problems are created by the lack of awareness and information about the disease among school personnel and in society. Even more, the majority of these children lack an opportunity to receive a high-quality education. Accordingly, respondents recognize the urgent need to educate school teachers, nurses, and other personnel.

During interviews, respondents were asked to express opinions about implementing online platforms for educating patients, parents, and other family members of patients with diabetes, school personnel, etc. This idea was unanimously liked and supported by all respondents, as it was recognized as potentially being effective and feasible.

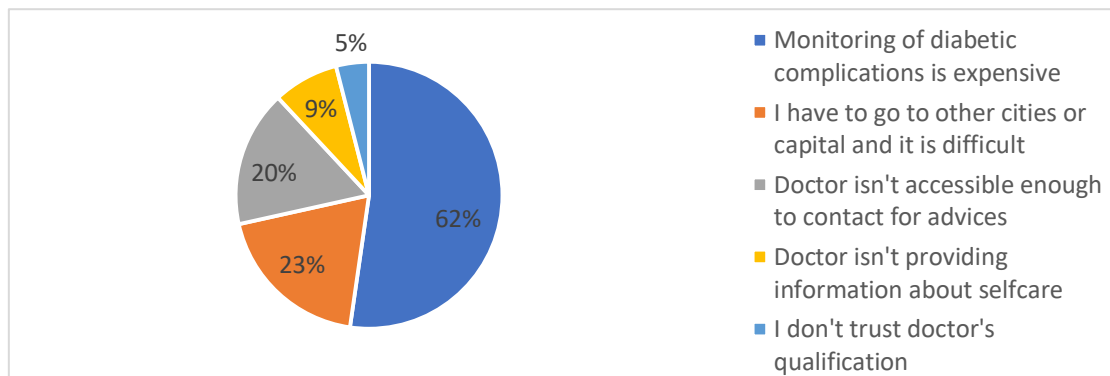
To continue with the results of quantitative studies, in the online survey of adult patients, 200 patients participated. This group was broken down as follows: (59%) had type 1 diabetes and (41%) - type 2 diabetes; (78%) of respondents were female and (22%) - male; (43%) lived in Tbilisi, and less than one in ten, (7%) _ resided abroad as emigrants, and the remaining number were from Georgian regions.

According to the results, the vast majority, (76%) of surveyed adult patients seek out endocrinologists in case of need, whereas (12%) indicated that they refer to self-treatment, and only 13% address the family doctor. When

respondents were asked about the frequency of referrals (how often they sought help from their family doctor or endocrinologist), (40%) responded that they visited the doctor only in the case of need, (23%) indicated visiting once in a quarter, (18%) - once in six months, (10%) - once in a month and an equal number (10%) chose the option "other". It should be emphasized that the purpose of visits to the endocrinologist or a family doctor for just over half (51%) of respondents was to receive a prescription for medicine. Three in ten, (29%) visited only in case of urgent need, for (27%) the reason was to obtain a referral and for other tests, (25%) - to control complications of diabetes and (8%) so to receive information (choosing more than one option/reason was possible).

When respondents were asked about the main complaints they had about medical services, (62%) answered, that the monitoring of diabetic complications is expensive, (23%) chose the option "I have to go to other cities or the capital and it is difficult", (20%) responded that the doctor is not accessible enough to contact for advice and one in ten, (9%) stated that the doctor is not providing any information about self-care, and 5% did not trust the doctor's qualification (Graph #1).

The main challenges about diabetes-related medical services:



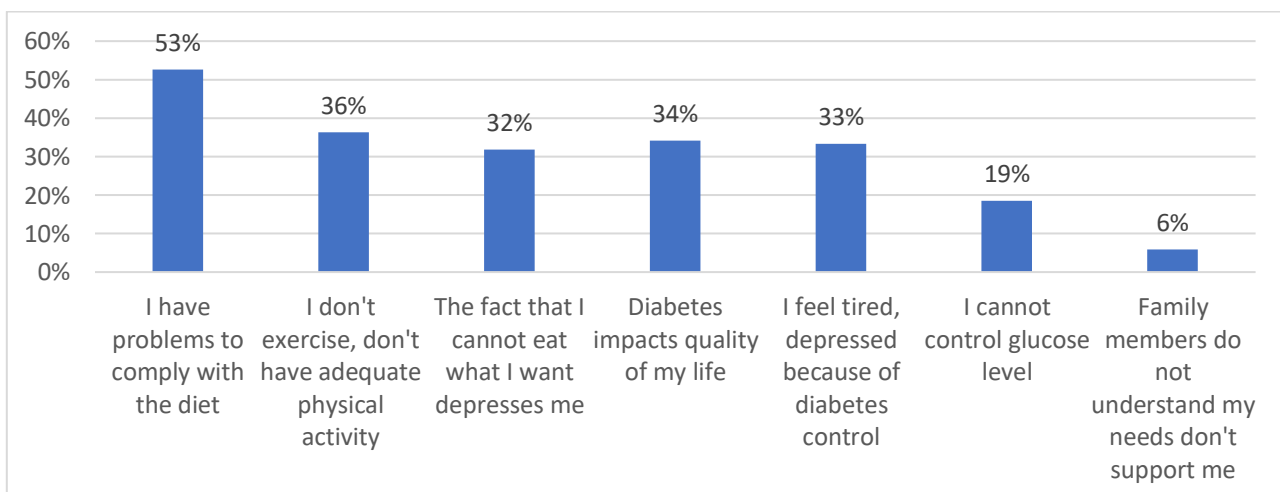
It should be emphasized, that when respondents were asked to indicate which tests and medical investigations they were undergoing periodically to monitor complications of diabetes, one-third, (30%) responded that they were not using any of the listed medical services.

It should be noted, that when respondents were questioned if they ever got any consultation about leading a healthy lifestyle, how to change behavior changeor about proper self-management, for purposes of their diabetes, 20% responded that they never had.

Another topic of inquiry was, to determine what type of information patients were receiving from endocrinologists (respondents were able to choose several answers at the same time). To illustrate the results, three quarters, (75%) of respondents answered they received information about control of glycemc and how to measure blood glucose; (72%) - about diet, (43%) about physical activity, (41%) about complications of diabetes and (18%) about self-care.

Another subject of the survey addressed the main problems and challenges that adult patients with diabetes faced. As the Graph below illustrates, the major problems for the respondents were difficulties to comply with the diet and physical activity. Furthermore, it is remarkable, just under two in ten respondents, (19%) answered that they were not able to control their blood glucose level.

What are the main problems and challenges related to diabetes?

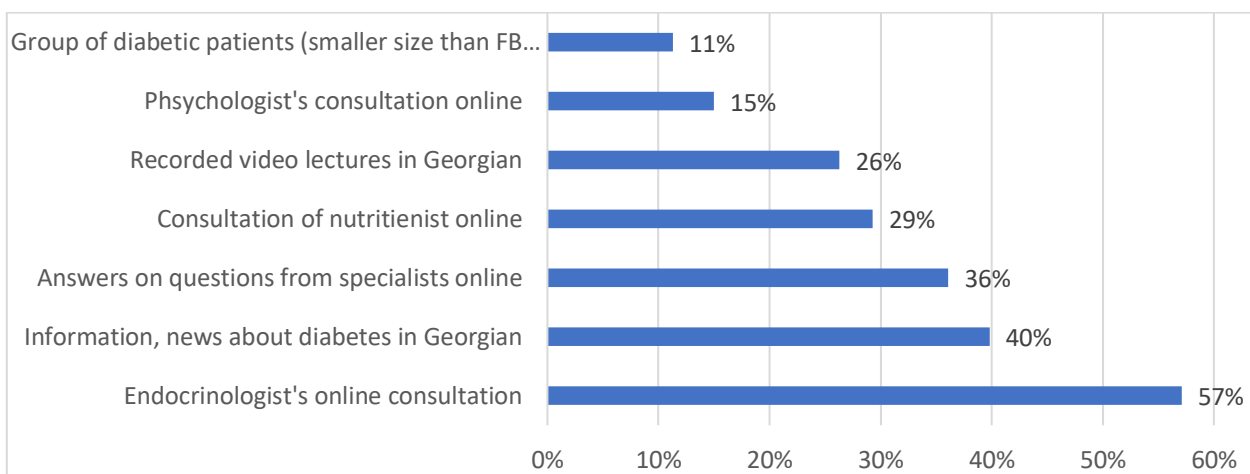


In terms of identifying what was their main source to receive information about diabetes. According to the respondents' answers: (39%) of patients, the main source of information is their endocrinologist, 29% - internet, for 20% - Facebook groups, and (8%) answered family doctor and nearly one in twenty, (4%) - listed "other". In terms of sources of information accessed, respondents were asked to indicate in which languages they would be able to read information and news about diabetes and its complications, 100% chose Georgian (official national language), whereas, just under two in ten opted (19%) for Russian, and 7% English, as options.

To assess patient attitudes towards online platforms and their readiness to access them, respondents were asked - if there were any online applications available what services

would be most important for them. As Graph #3 illustrates, the majority, (57%) indicated they would like to have an endocrinologist's online consultation accessible, (40%) - wanted information and news about diabetes. Fewer than four in ten, (36%) of respondents wanted answers to questions from specialists online, etc. Additionally, in response to another survey question, (43%) of respondents indicated that they would like to receive information about medicines for the treatment of diabetes, 31% wanted information about continuous glucose monitoring and about insulin pumps, (31%) about diet and nutrition, (28%) in terms of controlling high glucose levels, and one in four, (25%) about psychological support in diabetes management.

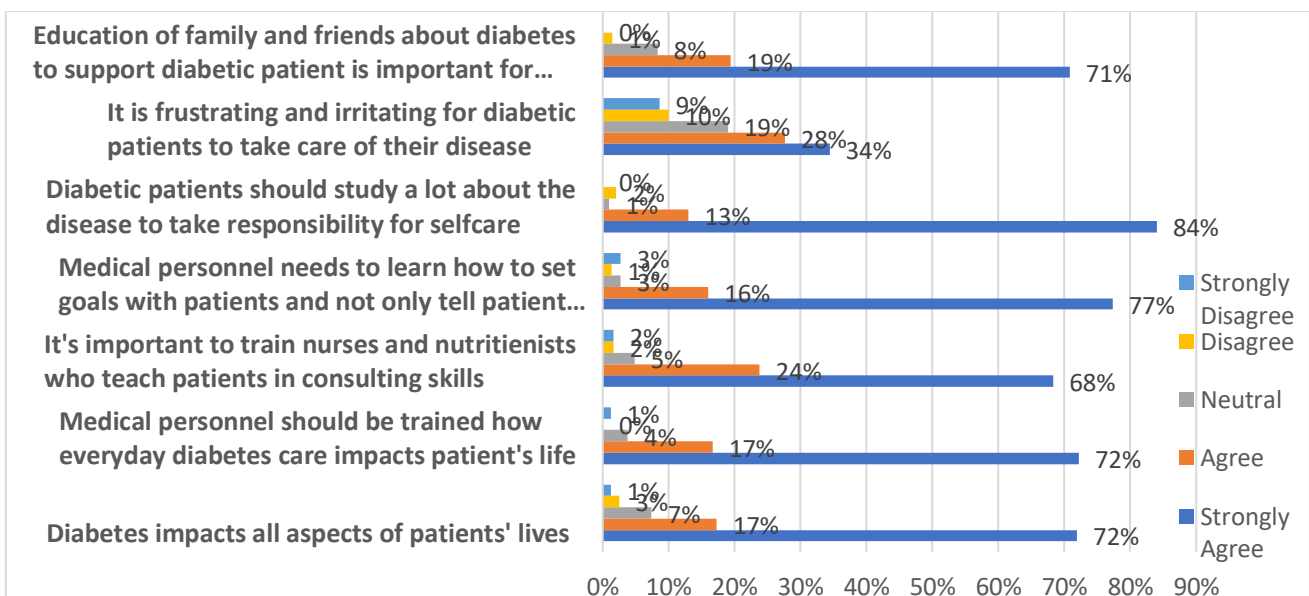
Services that would be interesting for the patients if they would be provided through the online platform



Finally, Graph #4 illustrates the attitudes of respondents towards important issues in diabetes management. It should be emphasized, that the vast majority, (77%) of respondents indicated they strongly agree, while 16% agree that medical personnel needs to learn how to set goals with patients instead of telling them what to do and simply giving instructions. Another

interesting finding is, (84%) of respondents strongly agree, and 13% agree that diabetic patients should learn as much as they can about the disease to better take responsibility for their care.

Attitudes of diabetic patients regarding important issues

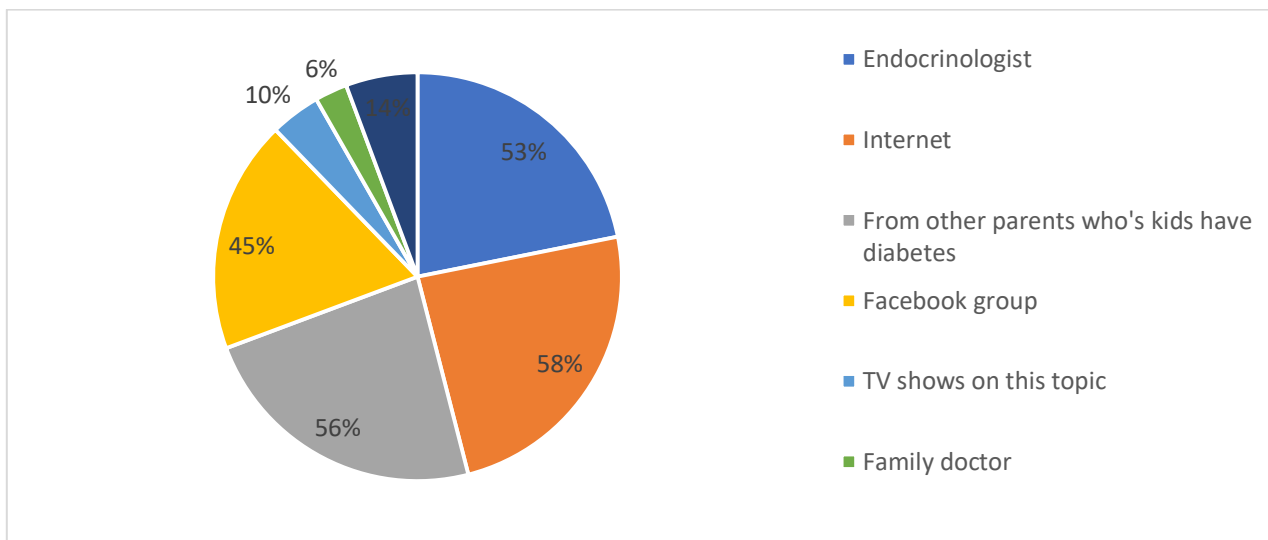


To continue with the results of an online survey for parents of children with type 1 diabetes, 175 respondents participated. The vast majority, (95%) of the respondents were mothers, (4%) fathers, and (1%) other caregivers. Just over half, (55%) of the children (whose parents participated in the survey) were female, (45%) male; (65%) lived in Tbilisi, and the rest in the regions of Georgia.

Parents were asked, if they possessed adequate information about type 1 diabetes, in their opinion. Only one in four, (25%) of respondents replied that they had got enough information, (42%) responded that it was desirable to have more information, (16%) said they needed more information, (12%) indicated they had questions they did not have answers. One in twenty, (5%) said they received a lot of information but it was difficult to figure out what their child needed specifically.

Furthermore, parents were asked to indicate the main sources of information they were using to acquire knowledge of how to care for their children's diabetes. Graph #5 illustrates responses in detail. Nearly six in ten respondents, (58%) said that they get their information mainly from the internet, over half, (53%) from an endocrinologist, (45%) from Facebook groups, (10%) from TV shows, etc. Although (58%) of the parents indicated they were relying on the internet, in response to another question trying to assess the easiness of an online information search, only 30% of parents answered that it was easy for them to find the needed information from the internet using different websites. Moreover, (44%) of respondents replied that it is difficult for them to find information online, 19% indicated that they mainly relied on social networks for information and support.

Main sources of information for parents, how to care for child's diabetes



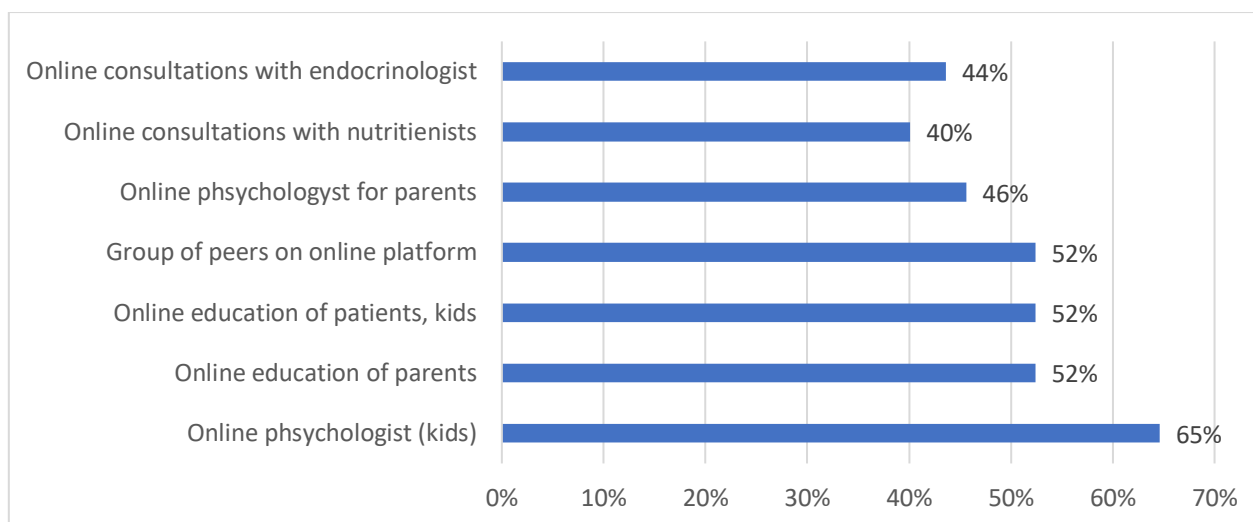
Another question of the survey was focused to evaluate parents' opinions - whose education and online information provision was mostly important regarding type 1 diabetes. As the results demonstrate, 81% of respondents perceive that kids themselves, parents and caregivers, school personnel, grandparents, and other family members should be educated (option "all the above-mentioned" included cited categories).

Another finding of the research is, that just under half, (49%) of the respondents use a Libre Flesh Glucose monitoring device, and (2%) use Dexcom CGM, whereas (49%) did not make use of any technologies. The main reason for not using the above-mentioned digital technologies, (78%) of parents indicated financial

constraints (a high cost of technologies) and nearly half, (49%) cited inaccessibility of continuous glucose monitoring technologies in Georgia as another major barrier.

The topic of inquiry was to evaluate parents' opinions and attitudes concerning the services that could support better care for children's diabetes if provided online. According to the results, (65%) of parents chose an online psychologist's consultation, (52%) chose an online education for parents and patients, (52%) said a group of peers on an online platform would support better care for their children's diabetes, etc. (Graph #6)

Which online services can support better care for children's diabetes: parents' opinions



IV. DISCUSSION

Analysis of the results of the conducted research reveals a significant deficit of the knowledge and information in patients with diabetes, as well as parents of children having type 1 diabetes concerning the management of the disease and its complications. As scientific evidence shows, a lack of such education and information can result in decreased self-care and patient engagement in the management of the disease.

Another identified problem is related to the newest medicines, treatment approaches, and technologies that are not widely used by specialists, nor covered by the state-funded diabetes program, in Georgia. Accordingly, the need to increase the qualification of endocrinologists, family doctors, nurses, and other personnel should be addressed (including practical skills and knowledge for broader adoption of digital technologies effectively used globally for better management of diabetes).

Furthermore, the need for digital technologies, such as CGM, Flash glucose monitoring, and insulin pumps for better management of diabetes is widely recognized by patients, endocrinologists, and experts. This need is especially drastic in the case of the children having type 1 diabetes, as the control of capillary glucose levels can create significant problems for patients, including psychological. However, as the results of the research revealed, financial constraints represent a major barrier for parents to utilize these technologies.

Patients with diabetes, living in the regions and rural areas have geographical accessibility problems (besides financial accessibility issues). This problem is especially exacerbated in the case of children having type 1 diabetes, since, there are towns with municipal units where children's endocrinologists are not accessible (or available). Therefore, patients are forced to travel to the capital of Georgia to visit specialists and for various medical services. This in turn is related to additional time and financial expenditures, as well as other difficulties for patients and their families. Another problem identified is the inexistence of multidisciplinary

teams for the management of patients having diabetes in Georgia's healthcare system. For this reason, endocrinologists have to perform the roles of psychologist and nutritionist. This is attributed to an overall lack of psychological support, decreased motivation for self-care, and negative behavior change worsens the management of the disease in children with diabetes, as well as among adult patients.

Consequently, digital technologies should be leveraged to enable virtual consultations of those specialists nonexistent in the regions and increase accessibility to various medical services. Moreover, as it appears the Covid-19 pandemic will continue for an extended period. Therefore, virtual consultations and online services should be stimulated and promoted by policymakers, to prevent further worsening of the management of diabetes and its complications.

As the results of the research demonstrate, patients and parents of children with diabetes, actively use the internet and social media as a source of the information. However, as observation of activities in closed Facebook groups revealed and according to the opinions of specialists enrolled in these groups, the recommendations and comments shared by members of these mediums are causing anxiety and alarm. Even more, as the results demonstrated for (44%) of the parents, it was difficult to find updated and relevant information about diabetes care on the internet. Consequently, online channels, as well as social network platforms should be leveraged and used properly by providers and policymakers, to make reliable and evidence-based information easily accessible for the patient community.

Based on the research, the following recommendations were elaborated. To improve the management of diabetes in Georgia, therapeutic education about diabetes, its complications, and self-care should be enhanced and supported in patients and parents of children with diabetes. Furthermore, accessibility to endocrinologists and other specialists should be increased (to get answers to the questions). One of the solutions to

these problems is the development of an electronic platform (content to be offered in native language) and broader adoption of telemedicine practices.

The purpose of the online platform should be to create an opportunity for patients and the parents of diabetic children to receive online consultations from endocrinologists, psychologists, nutritionists, and other specialists. At the same time, an online platform should be utilized for webinars, online meetings, for placement of up-to-date information (articles and other) translated in the native language, for placement of video lectures. This would help in answering frequently asked questions by patients and for personal interaction between them. Moreover, this kind of platform enables the inclusion of school personnel (as well as sports coaches and other teachers), which may include family members, so to educate them about diabetes-related issues.

In addition, the electronic platform should have a user-friendly design with consideration of existing applications, best practices, a built-in glucose monitoring diary for daily reporting, etc. The purpose behind this is improved doctor-patient communication, monitoring of disease features, and enhanced feedback. This, in turn, results in better management of the disease, and its many complications.

Another important opportunity provided by online platforms is the professional development of specialists in rural areas. More specifically, it can be used to increase the professional qualifications of doctors, as well as, to improve their skills for patient consultation, goal setting for behavior change, etc.

It should be emphasized, that (7%) of the participants, under one in ten, in the adult patients' (having diabetes) survey lived abroad as emigrants. Frequently, emigrants face various barriers such as – language, financial, insufficient time which were limiting factors in their access to medical services. An online platform for diabetes management can provide an opportunity for this category of patients as well, to receive updated and reliable information in their native language, and to connect remotely with various specialists as needed.

According to the research, access to glucose monitoring digital technologies should be increased in Georgia. Specifically, in the case of children having type 1 diabetes, continuous glucose monitoring devices should be covered to some extent (if not fully) by state-funded diabetes programs and consequently, maintenance and technical support issues facilitated with producers at the system level.

In the final analysis, education of the broader society should be considered, as well, to increase awareness about diabetes in the country and provide greater support for patients and their families.

V. CONCLUSION

In conclusion, it is important to direct effort towards an increase of patient engagement, self-care, and promotion of a healthy lifestyle. As the research demonstrates, behavior change requires specific approaches from the specialists and these should not be limited to diagnosing, treating, and providing instructions. Existing digital technologies afford opportunities to leverage online platforms to improve communication between doctors and patients, enhance feedback, and increase patient empowerment. Chronic diseases, and in particular, diabetes create many problems for patients and caregivers. However, patients and caregivers living in Georgia have many additional problems, which should be reduced by the execution of proper public health policy and integration of efforts of various stakeholders. This includes, but is not limited to including appropriate reimbursement of evidence-based digital technologies, as provided by both governmental and private insurance programs. Collectively this will be a great step forward. This in turn would mitigate the everyday routine for patients and to better enable them to achieve a higher quality of existence and be able to live more fulfilling lives despite their diabetes and other related medical conditions.

REFERENCES

- [1]. World Health Organization (WHO). Global Report on Diabetes. <https://www.who.int/publications/i/item/9789241565257>
- [2]. Animaw W, Seyoum Y. Increasing prevalence of diabetes mellitus in a developing country and its related factors. PLOS ONE. 2017;12(11):e0187670. doi:[10.1371/journal.pone.0187670](https://doi.org/10.1371/journal.pone.0187670)
- [3]. Shrivastava SR, Shrivastava PS, Ramasamy J. Role of self-care in management of diabetes mellitus. J Diabetes Metab Disord. 2013;12(1):14. doi:[10.1186/2251-6581-12-14](https://doi.org/10.1186/2251-6581-12-14)
- [4]. Shan R, Sarkar S, Martin SS. Digital health technology and mobile devices for the management of diabetes mellitus: state of the art. Diabetologia. 2019;62(6):877-887. doi:[10.1007/s00125-019-4864-7](https://doi.org/10.1007/s00125-019-4864-7)
- [5]. Xu Z, Yu D, Yin X, Zheng F, Li H. Socioeconomic status is associated with global diabetes prevalence. Oncotarget. 2017;8(27):44434-44439. doi:[10.18632/oncotarget.17902](https://doi.org/10.18632/oncotarget.17902)
- [6]. Animaw W, Seyoum Y. Increasing prevalence of diabetes mellitus in a developing country and its related factors. PLOS ONE. 2017;12(11):e0187670. doi:[10.1371/journal.pone.0187670](https://doi.org/10.1371/journal.pone.0187670)
- [7]. Noughjah, S., & Jahanfar, S. (2020). Challenges of diabetes care management in developing countries with a high incidence of COVID-19: A brief report. Diabetes & Metabolic Syndrome:
- [8]. Clinical Research & Reviews, 14(5), 731–732. <https://doi.org/10.1016/j.dsx.2020.05.012> [date accessed]

- [9]. Ezenwaka C, Eckel J. Prevention of diabetes complications in developing countries: time to intensify self-management education. *Archives of Physiology and Biochemistry*. 2011;117(5):251-253. doi:[10.3109/13813455.2011.602692](https://doi.org/10.3109/13813455.2011.602692)
- [10]. Diabetes Mellitus in Developing Countries and Case Series | IntechOpen. <https://www.intechopen.com/chapters/42090>
- [11]. International Labor Organization. 2020. COVID-19: Are there enough health workers? Available at: <https://ilostat.ilo.org/covid-19-are-there-enough-health-workers/>
- [12]. Karachaliou F, Simatos G, Simatou A. The Challenges in the Development of Diabetes Prevention and Care Models in Low-Income Settings. *Front Endocrinol (Lausanne)*. 2020;11:518. doi:[10.3389/fendo.2020.00518](https://doi.org/10.3389/fendo.2020.00518)
- [13]. Nuhjah S, Jahanfar S. Challenges of diabetes care management in developing countries with a high incidence of COVID-19: A brief report. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*. 2020;14(5):731-732. doi:[10.1016/j.dsx.2020.05.012](https://doi.org/10.1016/j.dsx.2020.05.012)
- [14]. World Health Organization. The Impact of COVID-19 Pandemic on Noncommunicable Disease Resources and Services. (<https://apps.who.int/iris/bitstream/handle/10665/334136/9789240010291-eng.pdf?sequence=1&isAllowed=y>)
- [15]. Su D, Zhou J, Kelley MS, et al. Does telemedicine improve treatment outcomes for diabetes? A meta-analysis of results from 55 randomized controlled trials. *Diabetes Research and Clinical Practice*. 2016;116:136-148. doi:[10.1016/j.diabres.2016.04.019](https://doi.org/10.1016/j.diabres.2016.04.019)
- [16]. Offringa R, Sheng T, Parks L, Clements M, Kerr D, Greenfield MS. Digital Diabetes Management Application Improves Glycemic Outcomes in People With Type 1 and Type 2 Diabetes. *J Diabetes Sci Technol*. 2018;12(3):701-708. doi:[10.1177/1932296817747291](https://doi.org/10.1177/1932296817747291)
- [17]. Alcántara-Aragón V. Improving patient self-care using diabetes technologies. *Ther Adv Endocrinol Metab*. 2019;10. doi:[10.1177/2042018818824215](https://doi.org/10.1177/2042018818824215)
- [18]. Shan R, Sarkar S, Martin SS. Digital health technology and mobile devices for the management of diabetes mellitus: state of the art. *Diabetologia*. 2019;62(6):877-887. doi:[10.1007/s00125-019-4864-7](https://doi.org/10.1007/s00125-019-4864-7)
- [19]. Kebede MM, Pischke CR. Popular Diabetes Apps and the Impact of Diabetes App Use on Self-Care Behaviour: A Survey Among the Digital Community of Persons With Diabetes on Social Media. *Front Endocrinol (Lausanne)*. 2019;10. doi:[10.3389/fendo.2019.00135](https://doi.org/10.3389/fendo.2019.00135)

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