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## Health literacy - a study of e-health messages with diabetic patients: the influence of e-health messages in patients' self-care

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## Abstract

The study verified whether the use of audiovisual resources in an application improves the effectiveness of e-health interventions, and whether it increases the levels of health knowledge in diabetic patients. An experimental, exploratory study with descriptive-qualitative and quantitative components was carried out in groups of diabetic patients (a control group, another that tested the application on smartphone and another that tested it on digital TV) from various socioeconomic levels in the city of Poços de Caldas, MG. There was a trend of improvement in literacy indicators, especially among those who tested the content on digital TV; it was observed that the higher level of literacy helps in receiving information, and that digital means help to improve levels of health literacy.

### Keywords

Literacy; Health communication; Mobile devices.

## Introduction

In 2016, it is estimated that diabetes was responsible for the death of 1.6 million people, corresponding to 4% of deaths caused by *Noncommunicable diseases*, NCD (WHO, 2020) and 3% of global mortality rates. In Brazil, according to the National Health Research of the Ministry of Health (MS) and the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística - IBGE, 2019), the biggest cause of Non-Communicable Diseases (NCDs) is diabetes, affecting nine million Brazilian people, corresponding to 7.7% of the adult population. In educational and communication terms, the interventions in the area of public health can be more effective if they are realized with people that are able to understand, identify and act on their health. This capacity is associated to the term literacy, which, when low regarding health, may be considered a risk factor for the treatment of all chronic diseases, diabetes among them (Santos, 2010), once the costs for the treatment of these diseases are high, especially towards the end of someone's lifetime, when they correspond to around 50% of health expenses (Alemayehu & Warner, 2004), besides the mortality rates and health impairments it causes (Araújo, 2007). Furthermore, according to IBGE (2017), around 7% of the country's population over 15 years old is illiterate; on the other hand, there are 276 million cell phones, and Brazilians spend about 5 hours and 26 minutes on the internet every day, of which 3 hours and 47 minutes are on their cell phone (Passos, 2015).

In this context, the *e-Health*, which directs the health care supported by electronic communication processes using the internet, cellular phones, among others (Ho, 2010) (Eysenbach, 2001) may be a solution (Campbell et al., 1999), and this interactivity may improve the learning process (Gustafson et al., 2005; Tremayne & Dunwoody, 2001) and the resulting performance of the patient (Glanz, Rimer & Lewis, 2002; Lefebvre et al, 2012).

The interest for interventions in communication and health through technologies and *media* has grown exponentially during the last decades (Ricciardi et al., 2013; Atkin & Rice, 2013) in order to verify the role that communication technologies may have in the improvement of the efficacy and efficiency of campaigns that promote health and well-being (Salmon & Atkin, 2011).

Thus, this study has an exploratory characteristic and sought to evaluate how the level of literacy intervenes in the reception of e-health messages through technologies (*Smartphone* and digital TV) for the self-management of patients with diabetes.

## Health literacy

Health literacy can be defined as the "degree in which individuals are capable of obtaining, processing and understanding information and services necessary to make adequate decisions regarding their health" (Manganello, 2008, p. 840) (Ad Hoc Committee On Health Literacy, 1999; Nielsen-Bohlman, Panzer & Kindig, 2004). It is a term relatively new in the health communication area and is associated to alphabetization, therefore, not only the capacity to receive and interpret messages, but to act on their understanding of the message. In Brazil, this subject is still not addressed enough and a greater interest arose after the implementation of a National Healthcare Promotion Politics in 2006 (Peres et al., 2017).

Studies show that changes in lifestyle through the "continuous education of people with diabetes result in weight loss, better control of blood sugar, blood pressure and lipids, and, consequently, reduce cardiovascular risks." (Teixeira & Zanetti, 2006, p. 812). The use of the *Smartphone* technology for continuous remote monitoring (Fagherazzi & Ravaud, 2019) also identifies risk patterns, improving the general situation of diabetes and its complications.

Creating and disseminating messages that are oriented to prevention have a higher probability of inducing a more responsible care with the person's own health (Zanetti, 2002; Glowacki, Mcglone & Bell, 2016). The improvement in literacy also helps a better reception (Sousa et al., 2015), adherence, and self-

management. Some authors characterize health literacy as a product of both individual capacities and the demands of the healthcare system (Baker, 2006).

Individuals with low levels of health literacy find obstacles to properly access healthcare services and may encounter challenges to communicate with healthcare providers or to make informed decisions to self-manage their disease. This level is also associated with higher expendable hospitalization rates and visits to the emergency room, less medicine accession, lower life quality and higher mortality rates (Poureslami et al., 2021).

## Media literacy

The use of the term media literacy also applies to a person's ability to read written words. However, thanks to technological advancements regarding communication through messages, people also need to understand about literacy associated with different means of communication. Potter (2019, p. 25) defines *media literacy* as an "ensemble of perspectives actively used in order to expose oneself to means of communication, as to interpret the meaning of the messages that are found. "

Besides, *media* literacy is a *continuum* and not a category and, thus, there are eight different stages (Potter, 2019): the first levels happen during infancy and growth: fundamental acquisition; language acquisition; narrative acquisition; development of skepticism; and, afterward, the more adult stages: intensive development, following the previous stage (many people stay their entire lives in this level), strong motivation to research information on certain topics; exploratory experimentation, which happens when *media* exposition is too narrow; critical appreciation, the level in which people become more knowledgeable about *media*; and social responsibility, the individual has a critical assessment to all types of *media* messages.

There are three blocks over which *media* literacy is built: personal *locus*, knowledge structures, and abilities, considering that these three factors are necessary to build a wide arrange of perspectives on *media* (Potter, 2019). The individual is considered the *locus* of literacy that provides mental energy and direction. It is also composed of goals and units, being that these goals shape the information and create division, processing tasks, determining what must be filtered and what must be ignored. The more it is known about it, the more it is possible to make informed decisions to shape it. *Media* literacy does not require the personal *locus* to always be engaged.

On the other hand, the knowledge structures are the organization of what is being learned. This structure helps to see the patterns, which will work as a map to determine where more information can be obtained and also where to recover information previously encoded in knowledge structures. Potter (2019) emphasized that information and knowledge are frequently used as synonyms, but they have different meanings: information is a transitory piece and is in the message; on the other hand, knowledge is structured, organized and resides in the memory.

Abilities are tools, and they act as muscle: the more they are exercised, the better they are. According to Potter (2019), there are seven *media* literacy abilities: **analysis**: dismembering a message in significant elements; **evaluation**: judging the value of an element through its comparison to other patterns; **grouping**: determining which elements are similar; **induction**: infer a pattern through a small group of elements, then generalizing a pattern from them; **deduction**: use of general principles to explain specific characteristics; **synthesis**: build elements in a new structure; and **abstraction**: create a brief, clear, and accurate description, capturing the message's essence.

The person may also use scales of learning related to cognitive, emotional, moral, and aesthetic appreciation, in relation to these abilities. According to a Report from the United Nations about Education, Science and Culture, (UNESCO, 2008, p. 7-8) media literacy (or media alphabetization and information - AMI) centers on the idea that information literacy about the process of prospection, analysis, and

comprehension of nature and mass communication,

The competences acquired by the media and informational literacy may be used to equip the citizens with critical thinking, allowing them to demand high quality service in the media and other Information providers (Wilson et al., 2013, p. 16).

## Methodology

The research sample was composed of 28 adults with diabetes over 18 years old in Poços de Caldas (South of Minas Gerais, Brazil), which has more than 168 thousand inhabitants (estimated population in 2020) and a Municipal Human Development Index (HDI-M) of 0.779 (2010), being considered one of the best in the State of Minas Gerais (IBGE). The study began in April 2016, and ended in July 2017.

- The people had to own a Smartphone or digital TVs. There were three distinct groups: Control Group, which didn't access any content and only had their literacy levels measured (10 participants);
- Group that tested the Smartphone application (9 participants);
- Group that tested the digital TV application (9 participants).

In essence, the research was a study of exploratory nature with a quantitative-descriptive component and other qualitative-descriptive elements, aiming to obtain causal and relational parameters through experimental study. It is considered causal (Creswell; Creswell, 2017) because it sought to establish a relation of cause and effect among the variables in the study, in a practical way. The investigation design adopted began with a descriptive-quantitative stage, verifying literacy parameters and usability of the tested application, followed, simultaneously, by a second exploratory-descriptive-qualitative stage, and a third causal comparative-qualitative and quantitative stage, with one control and two experimental groups (Smartphone and digital TV). On average, each interviewed person used the application for about a month in order to answer the last stage of the research.

The instruments used in the quantitative part were the *Diabetes Knowledge Scale* (DKN-A) (Dunn et al., 1994) and the *Newest Vital Sign* (NVS) (Weiss et al., 2005), the Brazilian Portuguese version (*IDTV Health*, 2013), with some adjustments to the language. The literacy related to the means of communication was also evaluated in a quantitative manner; and a script with questions was used to interview the *focus group* in depth.

The Lusophone University of Humanities and Technologies (Universidade Lusófona de Humanidades e Tecnologias – ULHT) was responsible for the assignment of materials and applications already developed in previous projects and made available with no costs. The study carried out in Brazil was part of a multicentric research, also carried out in other countries: Portugal, by the Lusophone University, and in the United States by the University of Texas. The studies resulting of this research were:

- Between 2015 and 2018. Improving Prenatal Health Communication: Engaging Men Via e-Health. Michael Mackert and colleagues (UT Austin, 2016); Manuel José Damásio (Lusophone University of Humanities and Technologies). Funding COLab Ut Austin.
- Between 2011 and 2017. UTA-Est/MAY/0012/2009 - "iDTV-HEALTH: Services included in the promotion of health and well-being through digital means" (project financed by FCT in the scope of the collaboration program between the University of Texas and the Portuguese State).

The text was translated to the Brazilian linguistic and cultural context. The adaptation for digital TV and inclusion of videos with subtitles and part of the tests were carried out in the Digital TV Laboratory at PUC Minas, on the *campus* located in Poços de Caldas. The application, called "Somos Saúde" ["We Are Health"], consists in an application adapted for digital TV and Smartphone, which provides various information (eating habits, exercises, tips, technical information, etc.) about diabetes, allowing the record

of blood glucose value, presenting them in a graphic, enabling the user to find locations and contacts related to healthcare near their location, and provides technical information about the application and the investigation.

The research sample in Brazil was of convenience, (Novelli, 2006) and Mattar, Oliveira and Motta (2014) classify this type of sample only as intentional sample (or judgment), since there was a selection of people and profiles that met the research strategies. Part of the participants were nominated by the Diabetic Association in Poços de Caldas, and part participated through an invitation made by the researcher, made through a post in the Association’s Facebook page. Another part was nominated by the researcher’s acquaintances. There were also nominations made by the Municipal Office, but due to access to the necessary technology for the application test, or even cognitive limitation, only one nomination was accepted.

The research was registered in the Plataforma Brasil [Brazil Platform] with the approval CAAE 53352915.3.0000.5137.

The patients were also classified according to their social and economic status in the Brazilian Criteria [Critério Brasil], provided by the Brazilian Association of Research Companies (Associação Brasileira de Empresas de Pesquisa - ABEP, 2015).

## Quantitative and statistical analysis

Pearson’s chi-squared test, or Fisher’s exact test, was used. In order to compare numerical variables among two groups, the Mann-Whitney test was used, and, among three groups, the Kruskal-Wallis test was used, due to the absence of normal distribution of the variables. The analysis of variance for repeated measures (ANOVA) was used, followed by the *Tukey post-hoc* test, with the variables transformed in *ranks* due to the absence of normal distribution. The significance for the statistical tests was 5%.

The Kappa and Krippendorff rates were used, where 0.6 is considered a substantial confidence. The result was over 0.94. In the qualitative stage, the coding and reliability validation test were made for the NVivo 11 software analysis, besides content assessment (Bardin, 2011)

## Material

An image that was associated with the research may be seen in Figure 1.

Figure 1 - Screen to select videos in the Smart TV application



Source: print screen of the application on the Windows 10 operational system.



## Results

The patients that tested the Smartphone and digital TV application mostly had type 1 diabetes: all the participants in the Smartphone group, and 77.7% of the digital TV group. However, the Control group was mostly (60%) composed by people with type 2 diabetes.

In terms of education, the Control group has the most participants who are university graduates and with higher education (technologist), a total of 60%. The Smartphone group also presents considerable higher education numbers: 33.3% are university graduates and 22.2% have master's degrees. The digital TV group is composed mostly by people with high school education (55%).

Technologically, the Control group is the one with the least access to digital TV, with only 40% of the interviewed people owning one. It is also the group that does not have total access to a Smartphone; while almost everyone in the other groups owns the equipment, 30% of the participants in this group do not.

The measurement of knowledge of aspects related to NVS diabetes had an increase in the Smartphone and digital TV groups, but had an accentuated decrease. In the Smartphone group, there was a rise in perception of questions related to knowledge about health. The response increased from 3.17 to 3.67. There was an improvement on the literacy of the people interviewed measured by this instrument. The respondents were, according to the theoretical references, close to three correct answers, which corresponds to limited literacy. With the improvement, they were closer to 4 correct answers, which represents an adequate level of health literacy. On the other hand, the average rate in the digital TV group was increased. The initial NVS average was closer to an almost adequate level, 3.7. With the considerable improvement in the NVS measures in practically all the items, an average superior to 4.33 was reached, which is considered adequate in health literacy.

However, the Control group did not have considerable improvements in their knowledge about health according to the NVS instrument. The group began with an average of 3, or a limited level of literacy, and ended with an average of 2.7, a 10% decrease. Only one item showed an increase in the numbers of correct answers, and there was a decrease of various other correct answers.

Regarding the knowledge measurement in a DKN methodology, two groups showed an increase in their averages from phase 1 to phase 3: the Control group, which went from 7.8 to 8.9, over 10% increase; and the digital TV, which went from 9.11 to 9.44. However, the *Smartphone* group showed a decrease in their average, from 8.44 to 8.33. This data can be observed in Table 2.

Table 2 - Literacy comparatives

| Group         | Initial literacy | Final literacy | Variation tendencies |
|---------------|------------------|----------------|----------------------|
| Smartphone    | 3.17             | 3.67           | NVS                  |
|               | 8.44             | 8.33           | DKN                  |
| Smart TV      | 3.77             | 4.33           | NVS                  |
|               | 9.11             | 9.44           | DKN                  |
| Control group | 3                | 2.7            | NVS                  |
|               | 7.8              | 8.9            | DKN                  |

Source: data collected by the researcher, 2018

During the e-literacy tests, the average time of execution for the first task realized in Smartphone was 36 seconds, this time decreased to 7.56 seconds in the second task, and 6.33 in the third task. On the other hand, on the digital TV the average time taken to execute the first task was relatively shorter, only 8.89 seconds, as was the second task, which took 3.33 seconds.

Regarding the evaluation of the digital TV and Smartphone application, both supports had positive feedbacks: the users considered the information relevant (scored 4.44 out of 5), easy to use (scored 4.61), the application has a clear function (4.5), with interesting and well-made content and features (4.28). Other positive aspects with lower scores (maximum of 5) were: pleasant to use (3.89), and helpful on the daily routine (3.83). Essentially, the application would be highly recommended (the score for the sentence "would not recommend" was very low, 0.22)

The use of the application is motivated in both groups, although some items got a higher score in the digital TV group. The main element of motivation was using and having benefits, which got the same score in both: score of 4.

## Discussion

The research has shown a reasonable level of integration with the technology among the groups that tested both supports and convenience in the use of e-Health applications. The mobility and information through the application were complimented and considered important, besides being recommended to other people with diabetes, which was also mentioned by Fagherazzi and Raval (2019). However, a paradox was also detected, since the interviewed people said they already knew the information. It was noticed that the transformation of information the users already had in an e-Health instrument changed the perception of what was already known and resulted in an appreciation of the content, considering that the importance and value of the information received was already declared.

The intervention in health communication emphasizes that the information control offers the user a higher level of satisfaction with the media, allowing a better learning process. This satisfaction was verified through one of the functionalities of the application, which was the control glycemic index, which was solicited for the development and recording of comparatives, besides the possibility of being realized as e-Health.

In a virtual environment, besides the amplification of the perception related to the importance of the information, it was clear that the information channels may be amplified both for the contact with professionals and the access of statements of people who have changed their behavior, and the use of messages to transmit benefits. Such concepts were also highlighted by Keer and colleagues (2013) and suggested by the people interviewed, besides the possibility of new connections.

It was noticed, through qualitative research, that there were two groups of these patients, and, as a result, with different levels of literacy, which interfere with adequate reception and adherence to the messages, behaving distinctly to the availed information. People who just got diagnosed with the disease go through a period of discovery and search for information; and the ones that are already in a more advanced stage of the treatment and behavior related to the disease. It is clear that self-management can be different between beginners and those who already control their diabetes, as stated by Kueh and colleagues (2015) and Sarfati and colleagues (2018) - media offers a potential way of reducing the pressure over healthcare services, as well as self-management strategies.

If the application had that possibility for the tests, the evaluation and reception would certainly be different at the end of the research, as would the various elements of self-management motivation. In the perspective of verifying different literacies, as a consequence of the different stages of the disease, the statements made by Berkman, Davis and McCormack (2010) are confirmed: knowing the level of health literacy is superior or inferior related to the complexity of the person's health situation and the



depth of information they have and that they will receive, because the numbers in health literacy could be influenced if the materials and universal principles of communication related to health were clearer, making the information more easily understood and closer the individuals' ability levels.

As was said by most of the people interviewed, a large part of the information was already known, and so did not add anything new, although they were considered relevant and would be recommended to others. Therefore, considering the declarations, it is observed that the information can be transformed in categories, repeated and already learned information, the ones that will have a role in bringing awareness to the newly diagnosed, and the information that have a character of innovation and novelty, fostering a new behavior among the patients. Thus, the information can be rejected if they have already been seen and assimilated, or they may have a motivational role for the person who has the disease and is in its initial stages. Similarly, new information may add more knowledge for both groups.

According to Potter (2019), the knowledge structures are the organization of what has been learned, therefore, the information that has been memorized and carefully and precisely constructed is not only an ensemble of facts. As he stated, information is a piece, it is transitory and located in the message; knowledge, however, is structured, organized, and located in the person's memory. This structure formed in both types of public detected will make a lot of difference during the adequate reception of the message. It is also possible to infer that even if the receptors often receive data, they do not always go through the process of content transformation into information. Thus, the challenge of the application was being a relevant instrument with information that would be significant enough to act in the patients' knowledge and, in this way, it is possible to infer that the literacy level interfere in the adequate reception of the message, because the tests' results, even without statistical justification within the groups, demonstrate an influence tendency.

In the digital TV group, where a higher and lower literacies were measured - considered adequate - there was a development, but on both measurement instruments (NVS and DKN), unlike the groups cited above, in which the literacy was evaluated as average, digital TV was the only group that showed development in both instruments' measurements.

Only the digital TV group, which has adequate literacy levels, showed improvement on both literacy levels/measuring instruments: NVS and DKN. Contrary to the other groups with limited literacy (Smartphone and Control), the digital TV group performed better on both tests, and the other two groups only had a good performance in one of the tests. There was a better understanding of the information through technological support: the digital TV. Better literacy helps in the reception of information and similar content through digital supports that assist in changes in literacy levels, which may be the opposite of what was supposed, since the Control group showed an improvement in the DNK statistics. This group, in turn, did not use any type of support nor accessed any content. In this case, it was not possible to reach an exact conclusion about their abilities, but it is possible to verify that it was the group with the higher social and economic classification, with the higher age group (possibly more mature people), and higher educational levels - elements that were detected as means for a good development. Therefore, when the base elements are present, it is possible that the self-development may happen without too much effort, only placing the subject in contact with determined themes, or, in this case, data collection instruments and their different questions and possibilities. It is also pointed out that a large part of this group is composed by people with type 1 diabetes.

Considering the question of interference by the supports, the hypothesis is that a low e-literacy makes understanding the messages difficult, it was verified that all people interviewed had developed their e-literacy through the use of technology.

The motivation, which may be important in the development of literacy, in the use of the application every day was not as elevated, but, as was already stated, if other functions were all added and adjusted, they would increase motivation, with the possibility of bettering literacy and, consequently,

the improvement of self-management.

The use of the application was motivated in both groups, but the score in the digital TV group was higher, which reveals a greater involvement with the information in this support and the performance in both literacy measurements.

Two key factors for this evaluation are the e-health literacy (Mackert et al., 2016) and the involvement with the content, still considering Karnoe and colleagues (2018), as central factors in the modeling and the implementation efficacy. In this approach, it is noticed that the supports among the possibilities to obtain information and use of application - Smartphone and digital TV - for specific public among their perspective of use and abilities, and the difference of the devices in obtaining the information, as well as the access of young people and the elderly to both supports that were tested: the younger age group would be more inclined to use Smartphones, while the older age group would use the digital TV.

The interviewed people stated that the mediums are important in the mediation of information, but do not replace the interaction with healthcare professionals. The importance of medical doctors and healthcare professionals is a key element in information supply.

The e-literacy performed differently in the digital TV and Smartphone groups, however, the tasks that were solicited to both groups were executed by all the researched individuals. The information solicited was related to understanding more about diabetes (in both supports), finding the contact and address of the Diabetic Association in the application (SmartTV), finding the address and contact information of a drugstore (Smartphone), and consulting/registering the patient's own blood glucose levels. In the digital TV group, the tasks were executed faster both regarding average time and the different time measurements and similar tasks. Still, the research showed a reasonable level of interaction with technology among the groups.

## Final remarks

The adoption of technology in the health area will be a great step in a virtuous cycle of improvement of people that, by using these mechanisms, would contribute more for the improvement of the applications. As education increases the literacy levels, the content present in applications (e-Health), due to their availability, will certainly help the improvement of literacy levels, communication, and, consequently, self-management.

Overall, what is verified in this study is that an adequate level of literacy is an important apparatus for the reception of messages from media through technology, and even a key factor for the development of the personal *locus*, knowledge structures, and important abilities to a better communication process in the health area. The application itself will serve as a base for new personal achievements in an e-health context in literacy development. The technology in a healthcare context functions as a magnifier of development possibilities and improvements, since it maximizes the delivery of relevant messages, accordingly to the disease stages, at the same time that, due to the availability, in a chronic illness context, will bring medium and long-term benefits due to opening a relationship, dialog, and feedback in a system.

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