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Abstract

Objectives Most currently available medication self-management support tools do not meet the needs of patients with limited health literacy. Recently, tools that are better tailored to the needs of patients with limited health literacy have been developed. This study aimed to assess the usability of an animated diabetes information tool by patients with diabetes with limited and adequate health literacy levels.

Methods Participants with limited and adequate health literacy levels were selected based on three health literacy questions in a screening interview, and asked to use the tool three times a week, after which individual semistructured interviews were conducted. The interview topics were based on the technology acceptance model (i.e. perceived ease of use, perceived usefulness, and intention to use). Twenty-five patients with diabetes were included in the study.

Key findings All participants perceived the tool as easy to use due to a clear overview of topics and only personalized information being provided. Those with limited health literacy indicated that they had learned from the tool and had the intention to continue using it in the future. These participants also expressed the need for the tool to be more actively offered by healthcare professionals, while participants with adequate health literacy expressed the need for more in-depth information.

Conclusion The tailored self-management support tool was perceived as usable by all participants. To better serve them, the tool could be further improved by addressing the additional needs of people with limited as well as adequate health literacy.

Keywords: health literacy; medication information; usability; diabetes

Introduction

Diabetes mellitus is a complex chronic disease that requires extensive self-management.^[1] Self-management activities contribute to healthy outcomes and include maintaining a healthy diet and physical activity, monitoring diabetes control indicators, taking medication and coping with stress and emotions.^[1, 2] Many patients experience difficulty with self-management tasks involving medication.^[1, 2] Inadequate medication self-management can accelerate the onset of complications and deteriorate the quality of life of patients with diabetes.^[1, 3]

Medication self-management poses extra challenges for people with limited health literacy. Health literacy ‘encompasses people’s knowledge, motivation and competences to access, understand, appraise and apply health information to make judgments and take decisions in everyday life concerning health care, disease prevention and health promotion to maintain or improve quality of life during the life course’.^[4] In the Netherlands, 24.5% of the population has limited health literacy.^[5] People with limited health literacy often experience

difficulty in reading and writing as well as in communicating with their healthcare provider.^[6] Furthermore, medication information is often highly complex due to the use of difficult words, medical terms, abbreviations and long and compound sentences.^[7, 8]

Several studies have demonstrated that people with limited health literacy have different needs regarding information provision compared with people with adequate health literacy.^[8, 9] For example, people with limited health literacy may require more practical, tailored information and step-by-step explanations about performing certain actions, such as using a blood glucose meter.^[9] People with limited health literacy may be better able to remember information when it is presented as simple and understandable text and in plain language.^[10, 11] The use of videos or animations may improve the ability of people with limited health literacy to access, understand, appraise and apply information, and thus, may lead to improved knowledge.^[12] Moreover, this way of presenting information to people with limited health literacy may result in them perceiving the message as more positive and recalling

an equal amount of information as individuals with adequate health literacy.^[12]

Tools are available that aim to support patients with diabetes' medication self-management.^[13, 14] However, studies have shown that the tools available often do not meet the information needs of people with limited health literacy, partly because too little attention is paid to people with limited health literacy in the development of self-management support tools, and consequently, these people do not always use them.^[15] To reach this group, new tools have recently been developed for self-management that could meet the skills and needs of people with limited health literacy. An example of such a new, tailored tool is a Dutch tool for patients with diabetes called 'Watch Your Diabetes' (Dutch = '*KijkOpDiabetes*').

Recent research has demonstrated that healthcare professionals positively value the animated medication information included in the tool.^[16] However, how people with limited and adequate health literacy levels and diabetes perceive the ease of use and usefulness of such tools is unclear, as is whether they have the intention to use them. Therefore, the aim of this study was to assess the usability of this animated diabetes information tool by patients with diabetes with limited and adequate health literacy levels. Having better insight into the usability of this specific tool will help tool designers and developers to better tailor their products to this group of patients, and will help healthcare professionals to better implement these tools and support patients in using them.

Methods

A qualitative study was conducted from September 2021 to April 2022 that involved individual semistructured interviews with patients with diabetes. The interviews involved an interpretive approach with perspectives that embraced a view of reality as made meaningful by the patients' understanding of events. Patients with diabetes were recruited with convenience sampling in three community pharmacies in the province of Utrecht, the Netherlands, and through networks of students at the Utrecht University of Applied Sciences. For patient recruitment, there were two inclusion criteria: having Internet access and being treated with insulin or oral antidiabetic drugs (OADs). The participating pharmacists invited patients who have dispensed the most common diabetes medication (metformin or insulin) to participate in the study, either by telephone or when visiting the pharmacy. Furthermore, students of healthcare management at the Utrecht University of Applied Sciences were asked by email to ask patients with diabetes in their network to participate in the study.

One of the researchers (BV, male PhD student) with sufficient experience in conducting qualitative research, conducted an intake interview with potentially eligible participants, where information about the research was provided and background characteristics were collected. Then, the researcher estimated whether a person had limited health literacy based on the following three questions: (1) *Do you have difficulty reading information about medicines?* (2) *Do you have difficulty understanding the doctor's instructions?* (3) *Do you find it difficult to follow your doctor's instructions?* The first question was based on the validated brief questions of Chew,^[17] whereas the second and third questions were formulated to estimate broader health literacy skills than only reading and writing. If a patient answered at least one of the three questions affirmatively, then he or she was considered to have limited

health literacy; otherwise, the patient was considered to have adequate health literacy. At the end of the intake interview, the tool was personalized by the researcher on gender, age and the medication and blood glucose meters used, resulting in participants only receiving information that applied to them. The participants were sent a link to the tool and were instructed how to open the link and were instructed to use the tool three times a week. The informed consent was signed by all participants or verbal consent was given during the intake interview, depending on whether it took place in the pharmacy or by telephone. The informed consent was written in an easy and understandable language, moreover, the informed consent was also explained orally.

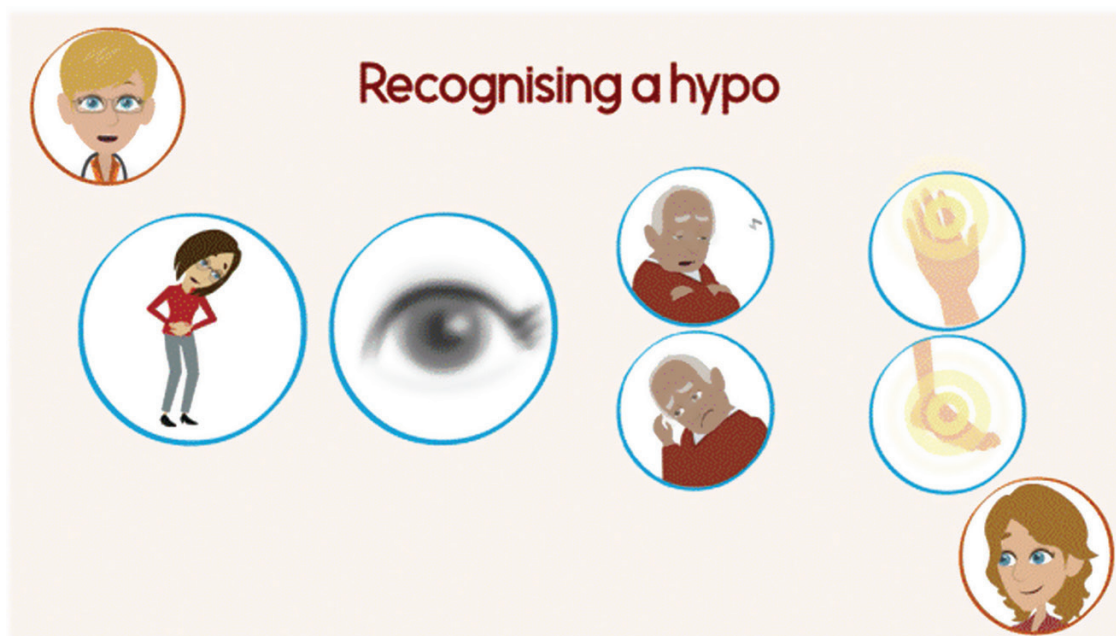
Approximately 7 days after the intake interview, the participants were contacted by telephone for an interview. The technology acceptance model (TAM) was used to develop the interview topics: perceived ease of use, perceived usefulness and intention to use ([Supplementary Material](#)).^[18] The topics and questions used in this study were checked for comprehensibility and feasibility by a pharmacist and an independent researcher and had already been used in previous studies.^[19, 20] The participants were also invited to express what they would like to see improved or included in the tool. The interviews were performed by one of the researchers (BV). The total number of interviews was based on data saturation. Specifically, two of the researchers (BV and RH) determined separately for participants with limited and adequate health literacy whether data saturation had been reached, by discussing whether two recent interviews had led to more information related to the aim. The research proposal was submitted to the Medical Research Ethics Committee Utrecht and they confirmed that the study was exempt from further ethical review. Therefore, the study needed no further ethical approval. This study also conformed to the provisions of the Declaration of Helsinki.^[21]

Content of WatchYourDiabetes

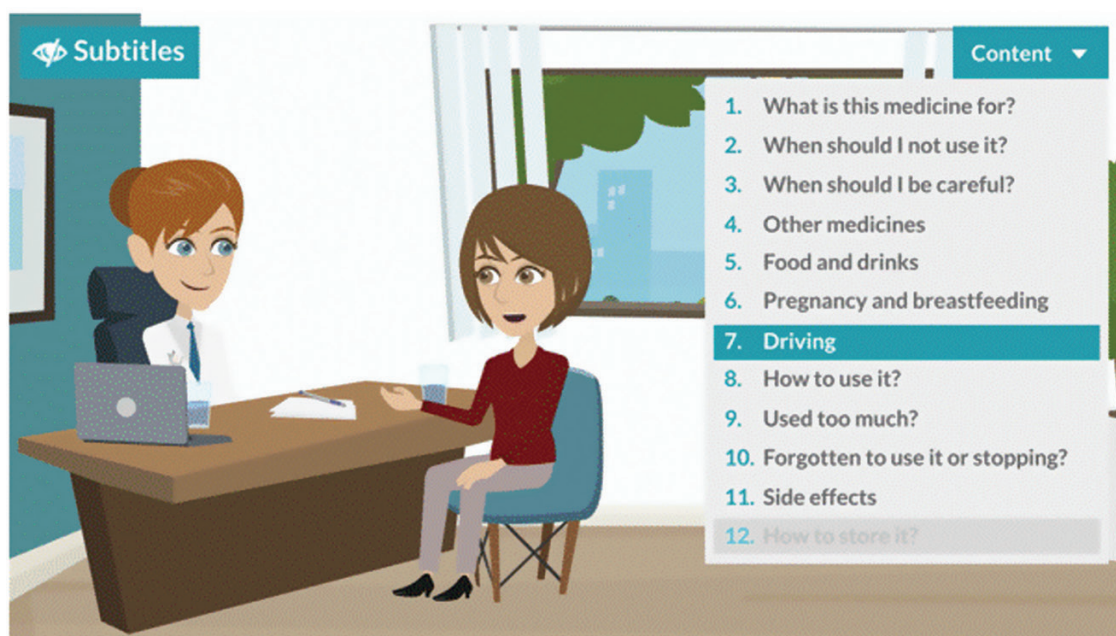
The tool provides information in understandable plain language with practical information to support diabetes self-management. Most of the information is presented through spoken animations; an animated healthcare professional and an animated patient are shown having a conversation about a diabetes-related topic ([Figure 1](#)). The WatchYourDiabetes tool provides 400 animation videos with information on diabetes, medication, blood glucose meters, symptoms, complications, the importance of blood glucose control and tips for daily living with diabetes ([Figure 2](#)). The tool is available in different languages (Dutch, English, Turkish and Arabic). Several animations included in the tool have been tested for comprehensibility by people with limited health literacy. The information of the tool can be categorized into three themes:

1. General: What is diabetes mellitus?; Why measure blood glucose?; Hyperglycaemia; Hypoglycaemia; Lifestyle, Foot care.
2. My treatment: Animations about my medication; My glucose meter; My insulin pump.
3. Tips for...: Illness; Vacation; To play sports.

In addition to animated videos, the tool includes options for users to get in touch with fellow patients with diabetes through an online platform, where patients can share



Animation about hypoglycemia



Animation about Dapagliflozin

Figure 1 Examples of spoken animations.

knowledge and experiences as well as perform a knowledge test to check whether they have understood the information. The videos are personalized by gender, age and the medication and blood glucose meters used; thus, the patient only receives information that is relevant to him/her.

Data management and analysis

The interviews were audio-recorded and transcribed verbatim. The transcripts were coded and analysed by one researcher (BV) using Atlas.ti 9 software package. A deductive thematic analysis was performed using the TAM as the theoretical foundation.^[22] The thematic analysis was performed in

the following six steps: becoming familiarized with the data, generating initial codes, searching for themes, reviewing the themes, naming the themes and categorizing them according to the TAM.^[22] To increase the reliability of the results, a sample of 20% of the interviews was analysed by a second researcher (RH). Where differences occurred, a consensus was reached through discussion with a third researcher (JR).

Results

A total of 25 eligible participants were recruited and had an intake interview with the researcher. Table 1 presents the

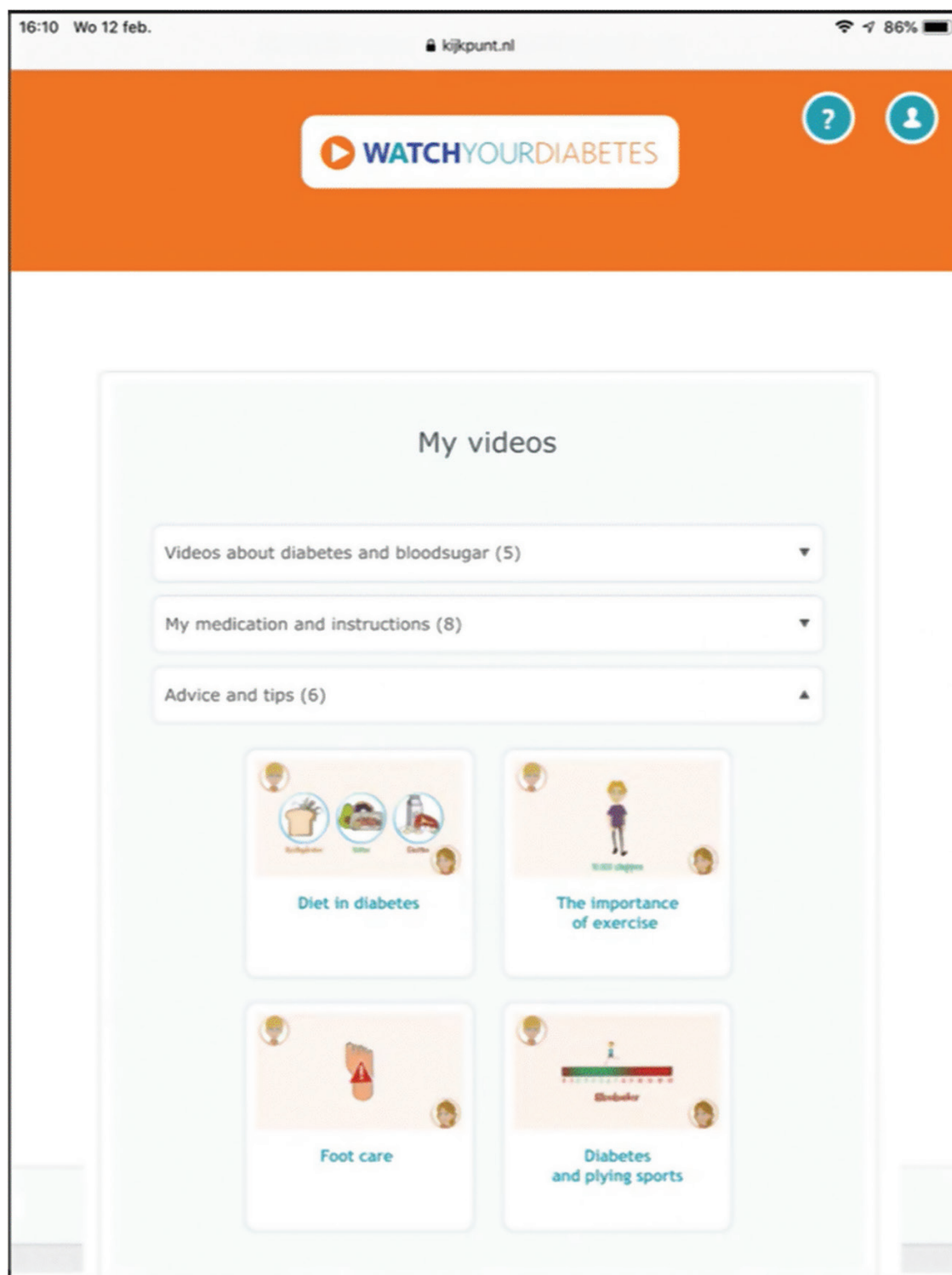


Figure 2 Main menu of the 'Watch Your Diabetes' tool.

background characteristics of the participants. For each topic of the TAM, the first part of the subsections that follow presents the general findings, while the second part presents and compares the opinions of participants with limited and adequate health literacy.

Ease of use

In general, most of the participants perceived the tool as easy to use and used the tool multiple times. The main reason that they gave was that they experienced the *navigation* of the

tool to be easy. They indicated that this was mainly because the tool was structured in a well-organized manner and the main menu provided a clear overview of the topics that can be found in the tool (Figure 1). The information from the themes 'general' and 'my treatment' were mainly viewed by people with limited health literacy and people with adequate health literacy also viewed the tips. The fact that only personalized information was presented further contributed to the perception of most participants that it was easy to use.

Table 1 Background characteristics of the participants (*n* = 25)

	Participant	Gender	Age	Diabetes mellitus type	Years since diagnosis	Type of medication	Comorbidities
Limited health literacy	LHL-1	Female	22	1	11	Insulin	
	LHL-2	Female	23	1	2	Insulin	
	LHL-3	Male	68	2	*	Insulin and OADs	Cardiovascular and epilepsy
	LHL-4	Male	89	2	1	OADs	
	LHL-5	Male	66	2	25	Insulin and OADs	
	LHL-6	Male	42	1	1	Insulin	
	LHL-7	Male	52	2	*	OADs	
	LHL-8	Male	67	2	*	Insulin and OADs	
	LHL-9	Female	69	2	19	Insulin	
	LHL-10	Male	63	2	5	OADs	Cardiovascular
	LHL-11	Male	67	2	25	Insulin and OADs	Cardiovascular
	LHL-12	Male	69	2	8	OADs	Cardiovascular
Adequate health literacy	AHL-1	Female	49	2	11	Insulin	
	AHL-2	Female	32	1	11	Insulin	
	AHL-3	Female	23	1	12	Insulin	
	AHL-4	Female	57	2	*	OADs	Lupus
	AHL-5	Male	50	1	37	Insulin	Osteoarthritis, retinopathy, neuropathy, thyroid problems
	AHL-6	Male	80	2	12	OADs	
	AHL-7	Male	83	2	7	OADs	Cardiovascular &
	AHL-8	Male	31	1	12	Insulin	
	AHL-9	Female	31	1	27	Insulin	Graves
	AHL-10	Female	68	2	2	OADs	
	AHL-11	Female	69	2	15	OADs	Chronic Leukaemia
	AHL-12	Female	72	2	27	Insulin and OADs	
	AHL-13	Female	57	2	2	OADs	Cardiovascular, asthma, thyroid problems

*Unknown by the participants; LHL-number = Participant with limited health literacy – Participant number; AHL-number = Participant with adequate health literacy – Participant number

Some participants with limited health literacy perceived *difficulty in using the tool*. They indicated that they had difficulty opening the link in the email to access the tool, opening the information videos, and using a computer in general. In the end, most of the experienced technical problems were solved through trial and error.

“What I noticed is that sometimes I found it complicated to go back to all the videos. It ended up just being on a button. But I missed that button. So I clicked on a video and I didn’t know how to get back to all the videos together” – LHL4.

Second, differences existed in *the device on which the tool was used* – that is, on a computer or smartphone. The participants with adequate health literacy more often opened the tool on a smartphone compared with the participants with limited health literacy, who opened the tool on a computer. Some participants with adequate health literacy tried using both devices, and they perceived the interface of the tool on the phone as more difficult compared with that on the computer because the information was difficult to read due to the small font size.

Perceived usefulness

Almost all participants indicated that they perceived the tool as useful in the provision of information about diabetes, for which they provided several reasons. First, it was mentioned that *the tool can be used on demand*, so they can choose the desired time to use the tool and the information can be repeated to enable them to understand it.

“I think this is a relief... when I get out of the hospital I always get a lot of information... You forgot that at home, but now you have a video” – LHL8.

Second, they perceived it useful that the *information is applicable to their situation*. Almost all participants liked that the tool was personalized and that they did not have to search for reliable information that specifically applies to them through an overwhelming amount of information on the Internet.

Furthermore, differences existed in perceived usefulness between participants with limited and adequate health literacy. The first difference was in the extent to which the participants stated that they *learned* from the tool. In particular, participants with limited health literacy indicated that they had learned about diabetes through using the tool. They indicated that the tool was highly valuable to them because, according to them, there are almost no websites with diabetes information that they can understand. The participants with adequate health literacy sometimes indicated that they had learned through using the tool, but they often already knew most of the information and skills. Second, differences existed in the use of the tool’s *interactive options* that focused more on skills, these were only mentioned by participants with adequate health literacy, and they perceived them as useful options. They perceived these options to be related to increasing their knowledge and applying it in daily life with diabetes. Third, differences existed in the *way the strategies on presenting information* were perceived. More than half of the participants with adequate health literacy and all of the participants with limited health literacy experienced the spoken animations as

a pleasant and useful way to receive information, and as much more pleasant and understandable than, for example, information through a package leaflet. However, a few participants with adequate health literacy indicated that the animations were long-winded and childish and perceived the voices in the animations as unrealistic.

“Sometimes I thought, ‘Please speak a little faster’” – AHL1.

Intention to use

Most participants would *recommend the tool* to other patients with diabetes. All of the participants would recommend the tool to people who have just been diagnosed with diabetes and to people in the social environment (e.g. colleagues and family members) of patients with diabetes.

“You could also inform that environment, take a look at Watch Your Diabetes. Then it would give insights to others who may not have diabetes. Your parents or something... Then you also have an idea of what it is. Everyone has an idea. I have an idea of what it is. Then you often think about old people with diabetes” – LHL6.

Moreover, the participants indicated that when one is diagnosed with diabetes, too much information is provided. For patients at this stage, in particular, the tool contains only the relevant information for learning about diabetes and its treatment and, according to the participants, these patients will benefit most from the tool. In addition, they recommended the tool for use by people in their social environments, because in the participants’ opinions there are still many misunderstandings about diabetes. Therefore, it would be helpful for people within their social environment to understand what life with diabetes is like.

A large proportion of the participants with limited health literacy and half of those with adequate health literacy indicated that they had the *intention to continue using the tool* in the future. The participants with limited health literacy mainly preferred to continue to use it for reading information again to understand it better or if they have forgotten parts. The participants with adequate health literacy wanted to use the tool to monitor new developments in diabetes. Some of the participants did *not intend to continue using the tool* in the future. The main reason for those participants with limited health literacy was that they prefer to receive verbal information from healthcare professionals because they consider it more reliable than all of the other information that can be found. The main reason for people with adequate health literacy was that they already knew everything they wanted to know about diabetes.

Suggestions for improvement

Most participants indicated that they would like to have *written information presented besides the animated videos*. The participants with limited health literacy wanted to be able to read the information again if the animation was too fast, whereas those with adequate health literacy felt that it would enable them to go through the information faster.

“I would like it, if you could read the text again, so that you no longer have to watch the animation completely for certain information” – AHL2.

Half of the participants with limited health literacy stated that they would like to receive *instruction in healthcare practice on the use of the tool*, such as through using the tool for the first time together with a healthcare professional.

“It would be helpful for me if my pharmacist showed me how I could best use the tool” – LHL8.

Another suggestion for improvement was to *add extra options to the tool*. Some of the participants with limited health literacy skills stated that they would like one portal in which all appointments with healthcare professionals are listed and in which one can directly ask one’s healthcare provider a question. In their opinion, these extensions would be helpful for providing a better overview of their schedule as well as making it easier to contact a healthcare provider. The participants with adequate health literacy stated that they would like an enriched tool with more in-depth information about the topics currently covered in the tool, and also for this information to be extended with possible complications, more attention to lifestyle, and new developments. Moreover, they would prefer to have extra interactive options in the tool, such as the ability to check glucose levels. They expressed a strong preference for learning even more about diabetes and medication self-management.

Discussion

The aim of this study was to assess the usability of an animated diabetes information tool by patients with diabetes with limited and adequate health literacy levels and demonstrated that most participants considered the practical information, reliable and applicable to their situation as useful. In addition, most of the participants perceived the tool as easy to use because the information was offered with simple navigation, presented in understandable plain language, and could be acquired on demand. The participants especially recommended such a tool for people newly diagnosed with diabetes and for people within these patients’ social environments.

A strength of this study was that it explored which elements were experienced as usable and which elements require attention for people with limited or adequate health literacy. Until now, little research has been done into the usefulness of self-management tools for people with limited and adequate health literacy. The findings of this study could contribute to the sustainable use of other support tools, which may be beneficial for people with adequate and limited health literacy to understand, remember and interpret medication information. A limitation of this study was a potential selection bias caused by the convenience sampling method that was chosen. The participants might not have been a representative sample, but that does not detract from the purpose of this qualitative study; exploring experiences and opinions about the use of the tool by different patients. Another limitation is that usability testing was obtained through an interview and self-reported data and not through observation of using the tool. However, since we were primarily interested in patients’ experiences of usability and perceived barriers, subjective measures were also suitable to provide us with these insights.

Elements that may improve usability for people with limited health literacy

In general, the tool tested in this study was perceived as highly usable by participants with limited health literacy,

and therefore, they had the intention to continue using the tool. According to people with limited health literacy, three elements contribute to this: First, the practical and *easy-to-understand information* ensures that they perceive to learn more from the information in the tool compared with information from other sources. Second, *easy-to-use navigation and in the form of spoken animations* is especially valuable for people with limited health literacy. This is in line with the findings of previous studies; the use of animations in the provision of information to people with limited health literacy caused them to be more positive about the message and to be better able to remember and apply the information.^[12] Third, information *tailored to their own situation* with only the main message, thus ensuring that they no longer have to search and then select between large amounts of information (or a large number of sources).^[10, 11]

Difficulties with usability for people with limited health literacy

This study also provides insight into the difficulties experienced by people with limited health literacy when using a self-management support tool, some of them perceived *technical difficulties when using the tool*. They had problems with opening the link to the tool in the email, opening the information videos or using a computer in general. People with limited health literacy are more likely to have difficulties using the Internet and websites than people with adequate health literacy.^[23–25] For example, they have more difficulties scrolling, accessing links and searching for and finding information online.^[23, 24] Moreover, previous research indicated that the use of digital tools by patients with limited health literacy is lower than patients with adequate health literacy.^[26] Although patients with limited health literacy use digital tools less often than patients with adequate health literacy, they can sufficiently use the tools if they are properly supported.^[10, 11] To diminish the barrier of difficulty in using the tool, having someone who can provide instructions on how to use it is necessary. Therefore, to reach patients with limited health literacy and stimulate their use of the tool, actively offering the tool with tailored information by demonstrating it to patients and then guiding them in using it may be helpful.^[16]

Elements that may improve usability for people with adequate health literacy

The tool tested in this study that is tailored to the needs of people with limited health literacy was experienced as usable by people with adequate health literacy. The participants with adequate health literacy were already well-informed about living with diabetes and hardly learned any new knowledge or skills through using the tool. Participants with adequate health literacy *needed more in-depth information* as well as information about the latest developments to be presented in a more *interactive way* to make using such a tool attractive to them. Previous research has found that these patients prefer more in-depth information and more interactive sources of information compared with patients with limited health literacy.^[27, 28] A layered approach, where additional in-depth information is offered in another layer of the tool, may stimulate optimal usability for people with limited and adequate health literacy. By applying such layering, support tools could be offered to everyone and then tailored even further to the needs of all patients.

In conclusion, the tool assessed in this study was perceived as easy to use and usable by many patients with diabetes,

both with limited and adequate health literacy levels; however, some improvements can be made to further optimize it for use in both groups. Future research should investigate whether patients will use the tool. Subsequently, it will have to be investigated whether the use contributes to better medication self-management and whether this contributes to improved outcomes such as delaying complications and improving the quality of life of patients with diabetes.

Supplementary Material

Supplementary data are available at *International Journal of Pharmacy Practice* online.

Author Contributions

Boudewijn Visscher: Conceptualization, methodology, formal analysis, investigation, data curation, writing – original draft, visualization. Rob Heerdink: Conceptualization, methodology, writing – review and editing, supervision. Jany Rademakers: Conceptualization, methodology, writing – review and editing, supervision.

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Conflict of Interest

The author(s) declare that there are no conflicts of interest.

Data Availability Statement

The data underlying this article will be shared on reasonable request to the corresponding author.

References

1. Powers MA, Bardsley J, Cypress M et al. Diabetes self-management education and support in type 2 diabetes: a joint position statement of the American Diabetes Association, the American Association of Diabetes Educators, and the Academy of Nutrition and Dietetics. *Clin Diabetes* 2016; 34: 70–80. <https://doi.org/10.2337/diaclin.34.2.70>
2. Coyle ME, Francis K, Chapman Y. Self-management activities in diabetes care: a systematic review. *Aust Health Rev* 2013; 37: 513–22. <https://doi.org/10.1071/AH13060>
3. Zhao FF, Suhonen R, Koskinen S et al. Theory-based self-management educational interventions on patients with type 2 diabetes: a systematic review and meta-analysis of randomized controlled trials. *J Adv Nurs* 2017; 73: 812–33. <https://doi.org/10.1111/jan.13163>
4. Sorensen K, Van den Broucke S, Fullam J et al. Health literacy and public health: a systematic review and integration of definitions and models. *BMC Public Health* 2012; 12: 80–80. <https://doi.org/10.1186/1471-2458-12-80>
5. Willems A, Heijmans M, Brabers A et al. *Gezondheidsvaardigheden in nederland: Factsheet cijfers* 2021. 2019.
6. Henselmans I, Heijmans M, Rademakers J et al. Participation of chronic patients in medical consultations: patients' perceived efficacy, barriers and interest in support. *Health Expect* 2015; 18: 2375–88. <https://doi.org/10.1111/hex.12206>
7. Davis TC, Wolf MS, Bass PF 3rd et al. Literacy and misunderstanding prescription drug labels. *Ann Intern Med* 2006; 145: 887887894. <https://doi.org/10.7326/0003-4819-145-12-200612190-00144>
8. Zhang NJ, Terry A, McHorney CA. Impact of health literacy on medication adherence: a systematic review and meta-analysis. *Ann Pharmacother* 2014; 48: 741–51. <https://doi.org/10.1177/1060028014526562>
9. Visscher BB, Steunenberg B, Heerdink ER et al. Medication self-management support for people with diabetes and low health literacy: a needs assessment. *PLoS One* 2020; 15: e0232022. <https://doi.org/10.1371/journal.pone.0232022>
10. Meppelink CS, Smit EG, Buurman BM et al. Should we be afraid of simple messages? The effects of text difficulty and illustrations in people with low or high health literacy. *Health Commun* 2015; 30: 1181–9. <https://doi.org/10.1080/10410236.2015.1037425>
11. Stableford S, Mettger W. Plain language: a strategic response to the health literacy challenge. *J Public Health Policy* 2007; 28: 71–93. <https://doi.org/10.1057/palgrave.jphp.3200102>
12. Meppelink CS, van Weert JC, Haven CJ et al. The effectiveness of health animations in audiences with different health literacy levels: an experimental study. *J Med Internet Res* 2015; 17: e11. <https://doi.org/10.2196/jmir.3979>
13. Bailey SC, Belter LT, Pandit AU et al. The availability, functionality, and quality of mobile applications supporting medication self-management. *J Am Med Inform Assoc* 2014; 21: 542–6. <https://doi.org/10.1136/amiajnl-2013-002232>
14. Williams A, Manias E, Walker R. Interventions to improve medication adherence in people with multiple chronic conditions: a systematic review. *J Adv Nurs* 2008; 63: 132–43. <https://doi.org/10.1111/j.1365-2648.2008.04656.x>
15. Visscher BB, Steunenberg B, Heijmans M et al. Evidence on the effectiveness of health literacy interventions in the EU: a systematic review. *BMC Public Health* 2018; 18: 1414–7. <https://doi.org/10.1186/s12889-018-6331-7>
16. Visscher BB, Vervloet M, Te Paske R et al. Implementation of an animated medication information tool in community pharmacies, with a special focus on patients with limited health literacy. *Int J Pharm Pract* 2021; 29(6): 566–572. <https://doi.org/10.1093/ijpp/riab038>
17. Chew LD, Bradley KA, Boyko EJ. Brief questions to identify patients with inadequate health literacy. *Fam Med* 2004; 36: 588–94.
18. Venkatesh V, Davis FD. A model of the antecedents of perceived ease of use: development and test*. *Decis Sci* 1996; 27: 451–81. <https://doi.org/10.1111/j.1540-5915.1996.tb00860.x>
19. de Veer AJ, Peeters JM, Brabers AE et al. Determinants of the intention to use e-health by community dwelling older people. *BMC Health Serv Res* 2015; 15: 103–8. <https://doi.org/10.1186/s12913-015-0765-8>
20. Padilha JM, Machado PP, Ribeiro AL et al. Easiness, usefulness and intention to use a MOOC in nursing. *Nurse Educ Today* 2021; 97: 104705. <https://doi.org/10.1016/j.nedt.2020.104705>
21. General Assembly of the World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *J Am Coll Dent* 2014; 81: 14–8.
22. Braun V, Clarke V. What can “thematic analysis” offer health and wellbeing researchers? *Int J Qual Stud Health Well-being* 2014; 9: 26152. <https://doi.org/10.3402/qhw.v9.26152>
23. Birru MS, Monaco VM, Charles L et al. Internet usage by low-literacy adults seeking health information: an observational analysis. *J Med Internet Res* 2004; 6: e25. <https://doi.org/10.2196/jmir.6.3.e25>
24. Jensen JD, King AJ, Davis LA et al. Utilization of internet technology by low-income adults: the role of health literacy, health numeracy, and computer assistance. *J Aging Health* 2010; 22: 804–26. <https://doi.org/10.1177/0898264310366161>
25. Davis TC, Wolf MS, Bass PF 3rd et al. Literacy and misunderstanding prescription drug labels. *Ann Intern Med* 2006; 145: 887–94. <https://doi.org/10.7326/0003-4819-145-12-200612190-00144>
26. Ayre J, Cvejic E, Bonner C et al. Accounting for health literacy and intervention preferences when reducing unhealthy snacking: protocol for an online randomised controlled trial. *BMJ Open* 2019; 9: e028544–028544. <https://doi.org/10.1136/bmjopen-2018-028544>

27. Ellis J, Mullan J, Worsley A et al. The role of health literacy and social networks in arthritis patients' health information-seeking behavior: a qualitative study. *Int J Family Med* 2012; 2012: 397039. <https://doi.org/10.1155/2012/397039>
28. Bodie GD, Dutta MJ. Understanding health literacy for strategic health marketing: eHealth literacy, health disparities, and the digital divide. *Health Mark Q* 2008; 25: 175–203. <https://doi.org/10.1080/07359680802126301>