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# Faculteit Revalidatiewetenschappen

## master in de revalidatiewetenschappen en de kinesitherapie

***Masterthesis***

***Which app and sensor features do health professionals consider important in health-wearable devices? A survey study***

**Cato Coppejans**
**Leen Machiels**

Scriptie ingediend tot het behalen van de graad van master in de revalidatiewetenschappen en de kinesitherapie, afstudeerrichting revalidatiewetenschappen en kinesitherapie bij neurologische aandoeningen

**PROMOTOR :**

Prof. dr. Sarah MICHIELS

**BEGELEIDER :**

Mevrouw Sara DEMOEN

**2022**
**2023**

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# Preface

**Research context**

This study was conducted by students of the Faculty of Rehabilitation Sciences, Hasselt University, in collaboration with the Karel de Grote Hogeschool, Antwerp, in the framework of the PWO (*praktijkgericht wetenschappelijk onderzoek*) project 'Machine Learning at the Extreme Edge'. This research was conducted as part of the master's thesis in rehabilitation therapy, focusing on the domain of technology-supported rehabilitation research. More specifically, the theme of this study is health wearable devices with healthcare professionals as research population.

**Relevance of the research**

Health wearable devices have become very common in our daily lives. These devices can track various aspects of our health. Despite their increasing popularity, there are still many ways they can be used to improve patient outcomes in healthcare that haven't been explored yet. As healthcare professionals start to incorporate health wearables, an essential question emerges: "Which app and sensor features do health professionals consider important in health-wearable devices?" Without a definite response to this question, the potential of wearables in healthcare may remain unrealized. This issue is even more important now because the market for wearables is growing rapidly, with new devices and features being introduced all the time. The purpose of this study is therefore to answer this key question so that future wearables will be more tailored to the needs of healthcare professionals.

**Work distribution**

To begin with, conducting the literature review, drafting the questionnaire and collecting participants was done collaboratively, and an equal contribution was made to this. Leen then cleaned, processed and graphed the data. At the same time, Cato wrote the introduction and method section. After jointly discussing the results, it was decided that Leen would focus on providing text for the graphs and Cato would write the discussion. The conclusion was written in collaboration. Finally, Cato wrote the preface and the abstract. At all times there was clear communication and every decision was made together.

**Acknowledgements**

We would like to thank Prof. Dr. Sarah Michiels, from Hasselt University, for her dedication and help in writing our master's thesis. She guided us through this process with calmness and clarity. In addition, we would also like to thank Ms. Sara Demoen for her commitment and effort that guided us step by step closer to our final goal. We are proud of the project we are privileged to represent

## Abstract

**Background:** Health-wearables devices have become a substantial part of everyday life. These devices gained popularity in recent years offering a variety of health tracking features. Numerous studies have shown the beneficial impact of health wearables on patient populations.

**Objectives:** This study investigates which app and sensor features health professionals consider important in health-wearable devices in order to tailor future wearables to their needs.

**Methods:** This study employed a survey design and anonymously recruited Dutch-speaking healthcare professionals. The questionnaire was based on a literature study. Data were collected through *Qualtrics*, including both closed and open-ended questions. After excluding the participants who did not meet the eligibility criteria the data were analysed using *Microsoft Excel*.

**Results:** The survey responses offered valuable insights into the preferences regarding app and sensor features in health-wearable devices. The majority of the health professionals identified in-app reward, clear data visualization and sensor comfort level as important features. Additionally, health wearables should be designed for use both during therapy and at home. Visual instructions were also highlighted as a great aid in wearables. Lastly, greater education and training are needed to ensure that healthcare professionals can fully integrate the potential benefits of wearable systems in patient care.

**Conclusion:** This study provides insights into which features healthcare professionals find essential in health wearables. The results can guide the development of future wearables and provides a basis for further research in this area.



**Keywords:** Health-wearable devices, wearable technology, mhealth, survey study, user experience, health professionals

# Introduction

Health-wearables devices (hereafter *health wearables*) have become a substantial part of everyday life (Peng et al., 2022; Riley et al., 2011). These devices gained popularity in recent years offering a variety of health tracking features (Sergueeva et al., 2020). Health wearables are defined as technology that has the ability to measure and visualize various health parameters which are measured in real time (Yetisen et al., 2018). These health parameters can include temperature, blood pressure, heart rate, sleep quality and more (Shin et al., 2019). Health wearables usually consist of a sensor and an application (hereafter *app*). The sensor monitors multiple functions and is placed on the body. The sensor is often connected wirelessly to a device via Bluetooth or Wi-Fi. This sensor links to the app which in turn collects, interprets and visualizes the data. The app is usually available for iOS and Android and installs on a smartwatch, smartphone or tablet of the user. (Wearable, 2023). Wearable systems include smartwatches, fitness trackers, activity trackers, pedometers, heart rate monitors and more (Dunn et al., 2018; Henriksen et al., 2018). Mainstream examples of wearables that gained worldwide attention are Fitbit, Xiaomi and Apple watch (Jia et al., 2018).

Mobile app-based health promotion programs have been shown to provide better health outcomes and higher adherence to treatment in the general populations (Lee et al., 2018). These mobile health promotion programs are especially seen as a big opportunity for healthcare (Free et al., 2013; Payne et al., 2015) since it is an easy way to reach the target population (Mattila et al., 2013). Numerous studies have shown the beneficial impact of health wearables on a variety of patient populations. According to research on patients with type 2 diabetes and/or arterial hypertension mobile app-assisted self-care interventions are possible useful tools to measure patient's parameters such as blood glucose and blood pressure (Liu et al., 2020). In this particular population, there exists also a significant advantage in data entry, transmission and review between patient and health professional (Tran et al., 2012). Wearables have been shown to extend data collection on heart-failure patients outside of regular healthcare and are being incorporated into clinical trials (DeVore et al., 2019). Likewise, mobile-apps have been used to reduce risk factors, boost physical activity, and enhance dietary habits (Rabbi et al., 2015). Additional, because of the benefit of real-time feedback it makes participation in research for patients easier as they can receive

individual education (Tran et al., 2012). It is also found that their motivation is more easily sustained due to automatically sent text messages and communication between patients and health professionals (Mattila et al., 2008; Mattila et al., 2010). Furthermore, a systematic review focusing on physical activity provided evidence on these mobile health promotion programs which have the potential to change health behaviours of patients (Bort-Roig et al., 2014). This area of research has potential in many more domains. According to recent research, there are even more benefits to discover to improve patient outcomes in health care (Yetisen et al., 2018).

As health professionals, app developers and product designers begin to explore the potential of health wearables, one key issue rises to the surface: “Which features do healthcare professionals consider essential for use in a clinical context? (Huhn et al., 2022) Without a clear answer to this question, wearables may fail to provide their full potential to the healthcare sector. This problem is particularly pressing as the wearables market continues to grow, with an ever-increasing number of devices and features available (Chandrasekaran et al., 2020). Therefore, this study aims to investigate what app and sensor features health professionals consider important in health-wearable devices.

With this survey-study we attempt to provide a clear answer to the research question. The findings of this study aim to encourage app developers and product designers to tailor future wearables to the needs of health professionals to ensure the full integration of the potential benefits of wearable systems in patient care. The outcome of the research could additionally lower the threshold for clinicians to use wearables in their practice. As businesses of all sizes, from large corporations to start-ups, are creating new functionalities to meet the rising demand for healthcare wearables, this research is more than ever relevant (Dunn et al., 2018).

# Methodology

## Procedure

A literature study on wearables was done by students of the Faculty of Rehabilitation Sciences, Hasselt University. This literature review aimed to obtain an overview of previous studies surrounding the features of health wearables. A list was compiled, noting the research questions that have been answered along with their respective results. In this study, particular emphasis was placed on identifying areas that have not yet been investigated. What features have not yet been researched? What research questions remain unanswered?

A detailed questionnaire (see appendix A) based on the literature study was developed in collaboration with the Karel de Grote Hogeschool, Antwerp, in the framework of the PWO (*praktijkgericht wetenschappelijk onderzoek*) project 'Machine Learning at the Extreme Edge'. Since the questionnaire's target population was Dutch-speaking healthcare professionals, the researchers composed the survey questions in Dutch. The questionnaire consisted of nine sections, namely: (1) General, (2) The use of wearables, (3) Target group, (4) Data, (5) Energy consumption, (6) Willingness to pay, (7) The use of a wearable in exercise therapy, (8) Open questions, and (9) Education. The process of filling out the questionnaire was estimated to require approximately 15 minutes of participants' time. It included various question types, closed and open-ended queries, and 5-point scale items (1 = strongly agree; 5 = strongly disagree). The complete version of the questionnaire is available in Appendix A.

Once the questionnaire was finalized and the study was approved by the ethical committee, the online survey platform *Qualtrics* was used to collect data through various media channels.

## Participants

Initially, the questionnaire distribution commenced in June 2022 and persisted until September 2022 via social media channels, including Twitter and LinkedIn. Due to a low response rate, the survey was re-administered in September 2022. However, this time it was delivered via mail. The survey was officially concluded on 3 November 2022. Data collection was anonymous, and participants did not receive any form of reward for participating in the survey.

When the participants enrolled in the questionnaire, they were required to provide their consent to have their data used in the study. The study targeted Dutch-speaking healthcare students and professionals. Inclusion criteria required that participants were Dutch-speaking and either pursuing healthcare studies or practicing healthcare professionals. Additionally, participants who completed less than 9% of the questionnaire were also excluded from the study. Since completing less than 9 percent would mean that the research subject only filled in the demographics and did not answer any question related to the research question. Hence, no useful info could be extracted from the data. Participants who did not meet the eligibility criteria were excluded from the study

**Data analysis**

Once the data were collected, the dataset was converted into *Microsoft Excel*. Additionally, the dataset was cleaned and screened for missing values and other errors. The ordinal data of the Like-scale were assigned to the corresponding question. After excluding participants who did not meet the eligibility criteria, the data were analysed using *Microsoft Excel.* Descriptive statistics were used to calculate demographic information and frequencies in order to address the various sub-research questions across the nine sections of the questionnaire. Using *Microsoft Excel*, a series of figures was created to visualize these results. Since the ordinal data can be naturally ordered, but it is not known whether the difference between the possible answer options is evenly distributed, column graphs and stacked column graphs were the chosen visual representation

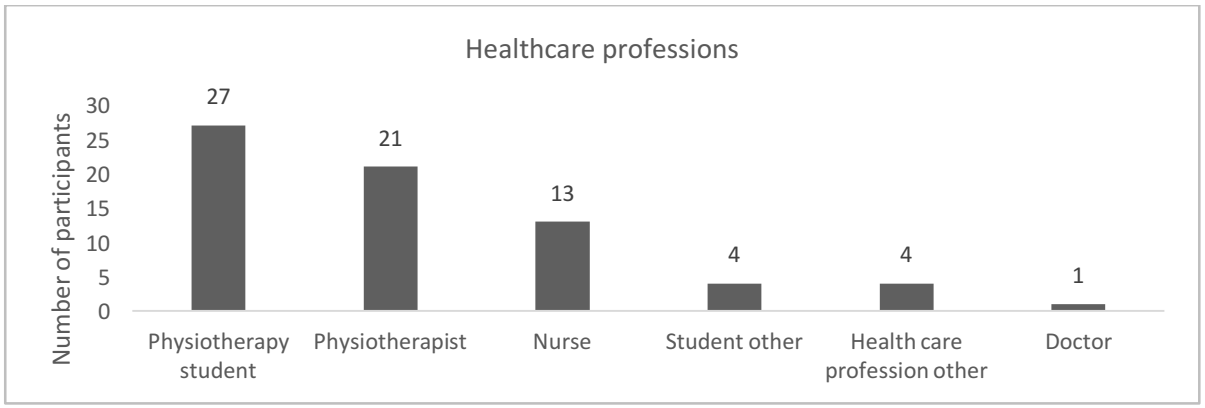
# Results

## General information about the participants

In total, 72 participants were included in the study. 60 out of 72 participants completed the questionnaire in its entirety, while the remaining 12 provided partial responses that still yielded relevant information. Excluded participants did not contribute any pertinent data to this study. Upon closer examination of the demographic data of the participants, it is observed that 69% of them consist of physiotherapy students and physiotherapists (Fig. 1). This study comprises 43.66 % student participants, forming a significant demographic with no prior work experience.

**Figure 1**

*General information of the participants*



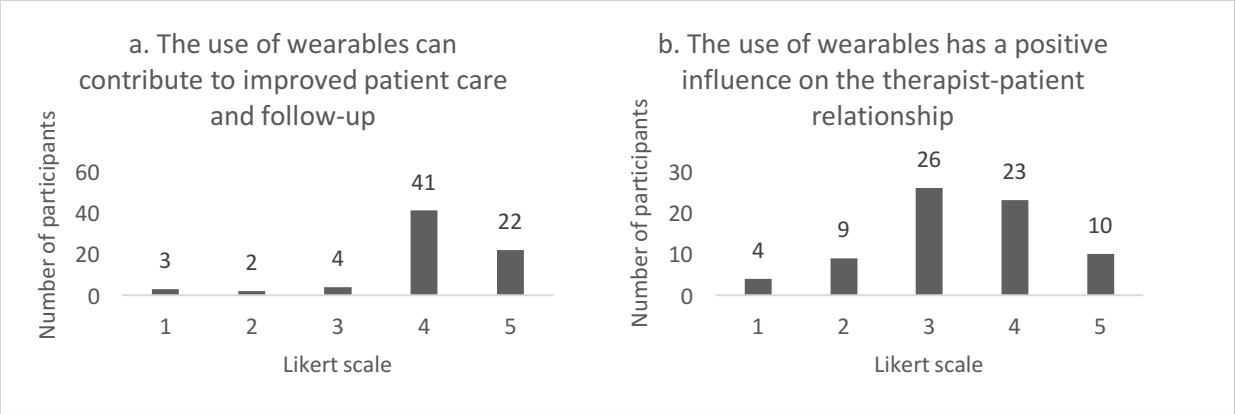

## The use of wearables

### Reasons for the use

The use of wearables systems in health care can have multiple benefits for patients. Participants believe that the use of wearables can improve patient care and follow-up. With more than 85% of participants agreeing, app developers should ensure that there is a capability in the app to enable follow-up monitoring. One other advantage that fewer participants agreed with is the improvement of the patient-therapist relationship. See Figure 2 for further details.

**Figure 2**

*Reasons for the use of wearables in healthcare*



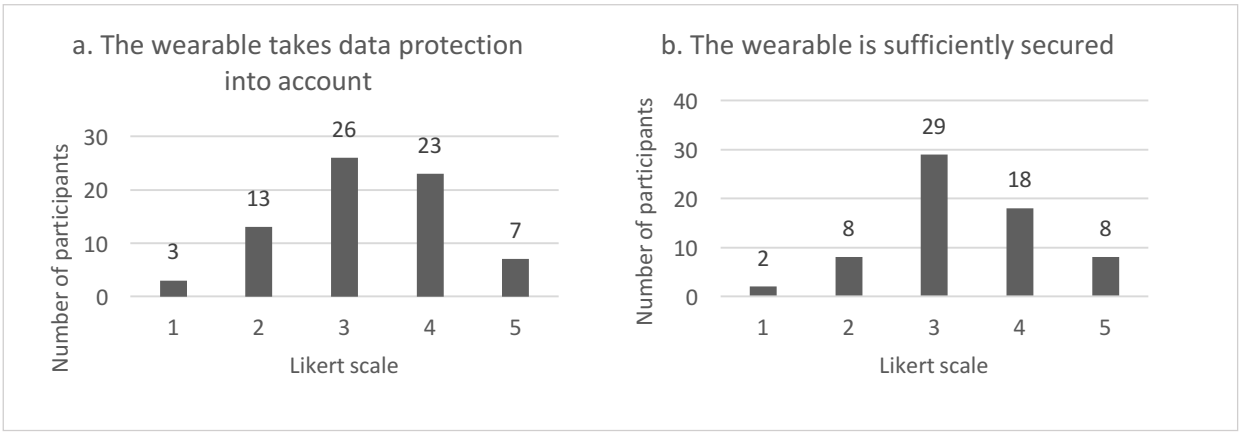

*Note. Likert scale data*

**Data security**

When developing an app, developers must be aware of the General Data Protection Regulation. Most participants are neutral about this statement. Furthermore, most participants are similarly neutral regarding the security of wearables. See Figure 3 for more details.

**Figure 3**

*Data protection and security*



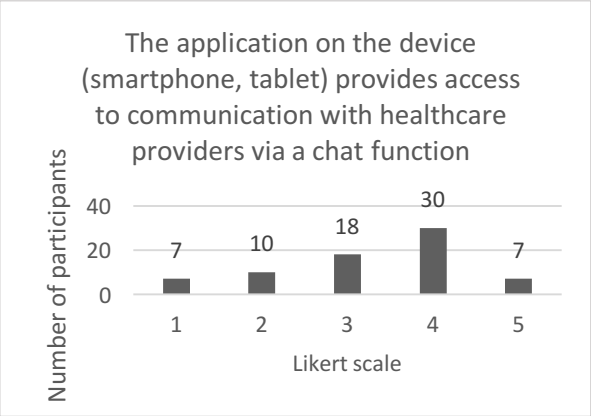

*Note. Likert scale data*

**Required features**

A chat function to enable communication with the healthcare provider is a possible feature that an app might incorporate. This could be used to remind the patient to perform his exercises. More than half of the participants perceived this as an added value in an app. More information and details about these features can be found in Figure 4.

**Figure 4**

*Communication with healthcare providers*



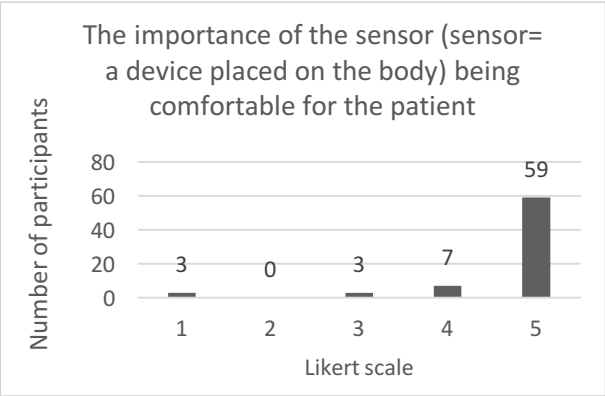

*Note. Likert scale data*

**Comfort of the sensor**

When manufacturing a sensor, it is important to ensure that it is comfortable for the patient as the sensor often sits against the skin, such as a heart rate monitor. More than 90% of participants agreed with this, due to this, developers and product designers will take comfort into account when designing the sensor. Further details can be found in Figure 5.

**Figure 5**

*Making a sensor of a wearable comfortable*



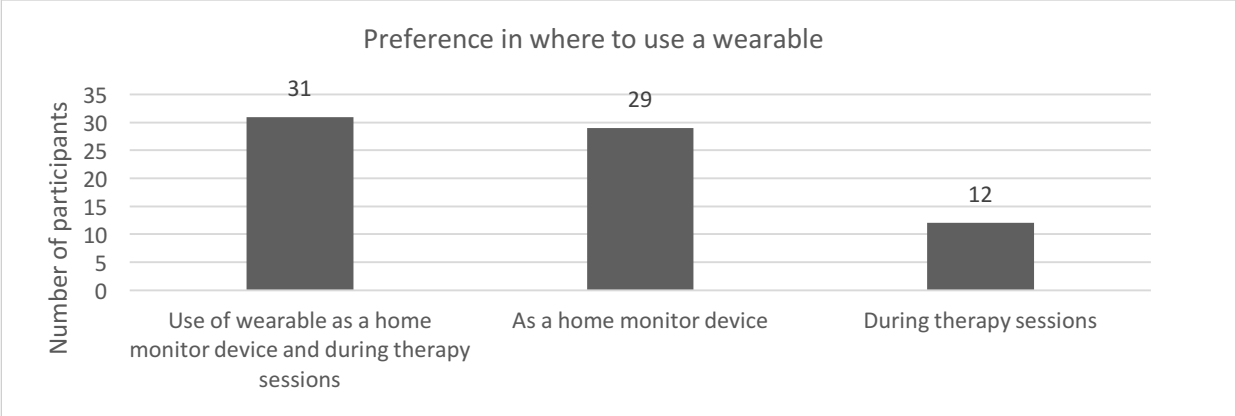

*Note. Likert scale data*

**Preference in where to use a wearable**

The majority of the participants want to use the wearable system both at home and during therapy sessions. For more details, refer to figure 6.

**Figure 6**

*Locations to use wearables*



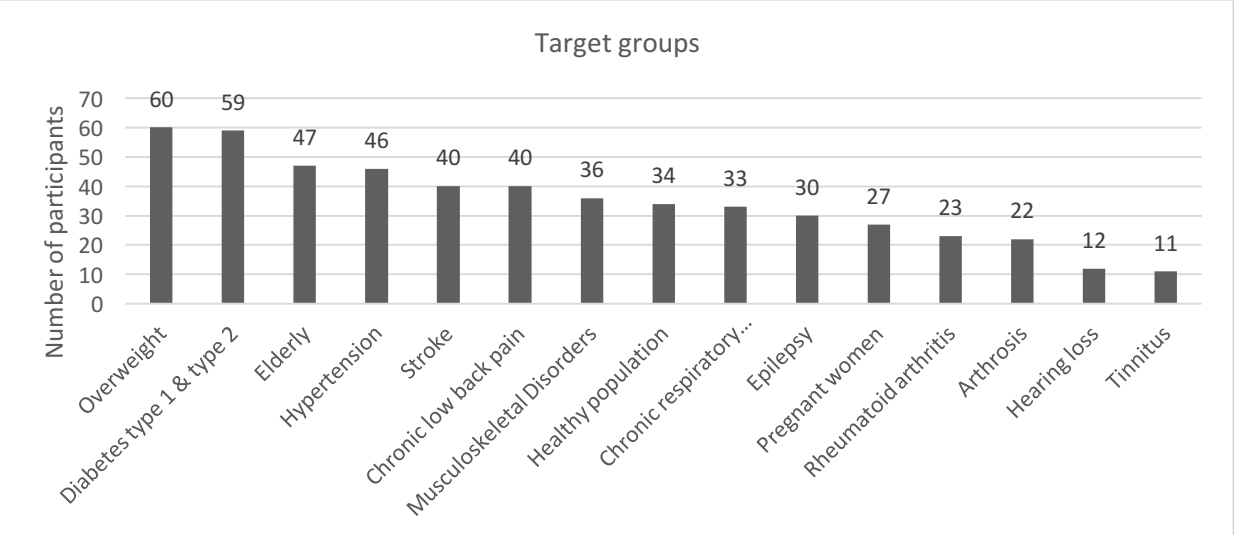
# Target groups

### Relevant target groups

The participants were asked to identify relevant target groups for an app, with overweight, type 1 and 2 diabetes, and the elderly being the most frequently selected options. Further information on relevant target groups for creating an app can be found in Figure 7. When developing an app for elderly users, consideration can be given to the common occurrence of visual impairments and lack of familiarity with technology among this age group. An app can be designed with a simple layout and larger font size to accommodate the needs of elderly users. Furthermore, participants identified other conditions that could benefit from the use of wearables. Specifically, an orthopedagogue and psychologist mentioned several psychological disorders, such as post-traumatic stress disorder (PTSD), low self-esteem, depression, anxiety disorders, and panic attacks. A nurse, on the other hand, suggested that patients undergoing home haemodialysis could benefit from a wearable. Lastly, physiotherapy students and physiotherapists noted that wearables could have added value for Parkinson's disease, cerebral palsy, children, and oncology patients.

**Figure 7**

*Important target groups*



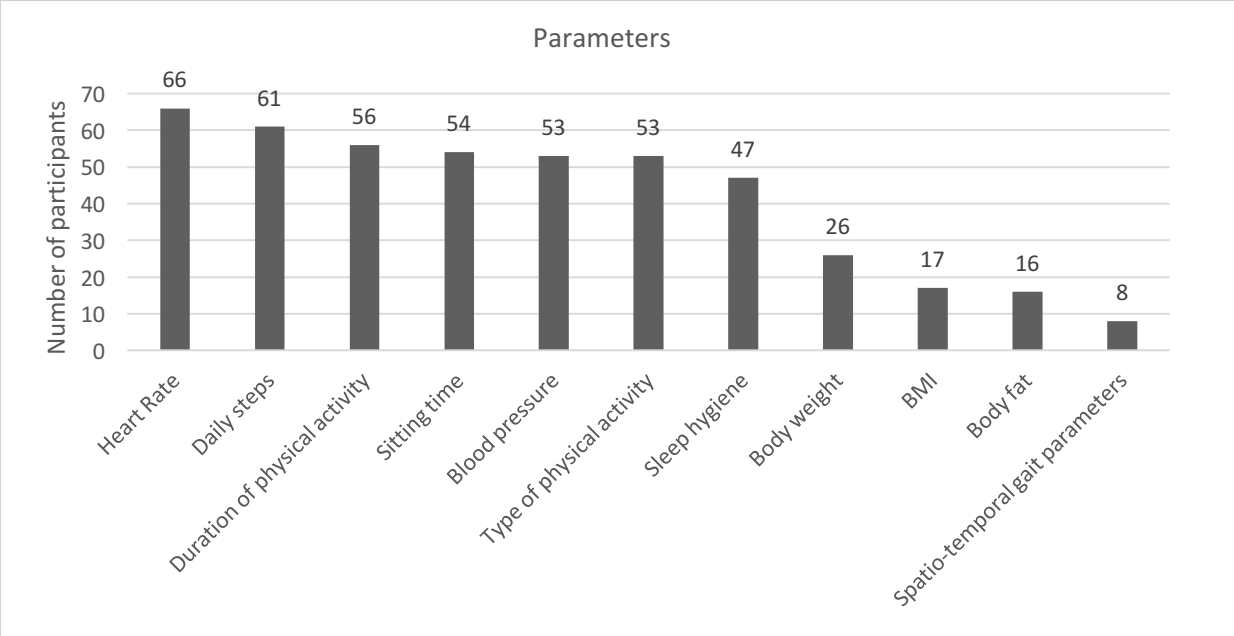
# Data

### Relevant parameters

Healthcare professionals consider heart rate, daily steps, and duration of physical activity as the most important parameters to measure. On the other hand, they consider spatio-temporal gait parameters, body fat, and BMI as the least relevant to track. Further details on relevant parameters for creating a wearable can be found in Figure 8.

**Figure 8**

*Important parameters*



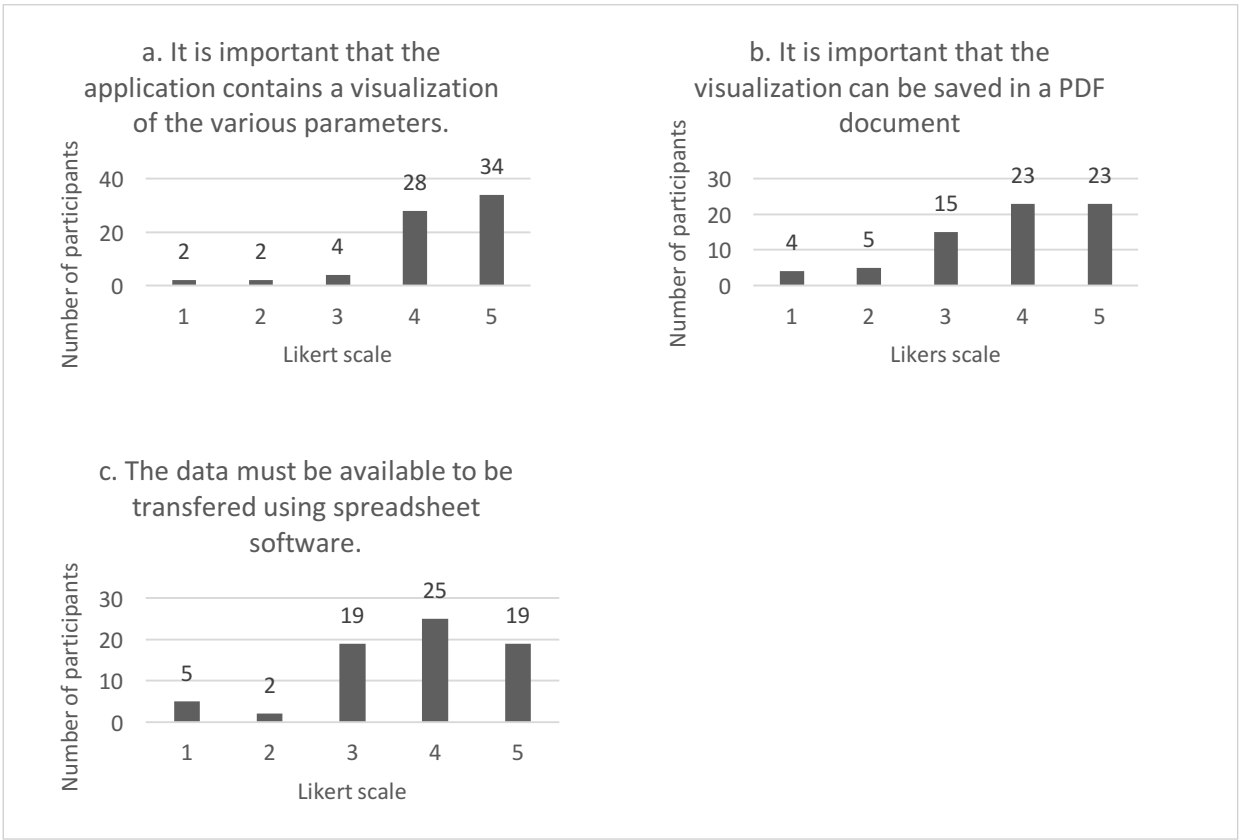

### Data visualisation and data availability

In addition to the sensor, there is an app. It is responsible for tracking the measured values and providing the ability to visualize the data. Figure 9 provides additional information on whether it is important for the app maker to visualize, process, and transport the data. An overwhelming majority of participants partially or fully agree that it is important for the app to provide a visualization of the various parameters. When designing an app, it is imperative to include a feature that allows for the visualization of the data. This visualization can be in the form of a graph, table, or figure. More than 60% of the participants agreed that this visualization can be saved in a PDF document, for example, to store the data externally outside of the app. Approximately the same number of participants agreed that they should be able

to transfer the data to spreadsheet software. Figure 9 provides further information. A feature that can add value to an app is the use of a cloud app. A cloud app facilitates data sharing via the internet. Data is stored online in the cloud, as opposed to being saved locally on a computer or USB stick. Saving and sharing of information both occur within the cloud. A slightly higher proportion of participants prioritize sharing information with their own therapist via a cloud app, compared to sharing it with their general practitioner. For more details, refer to Figure 9; 10; 11.

**Figure 9**

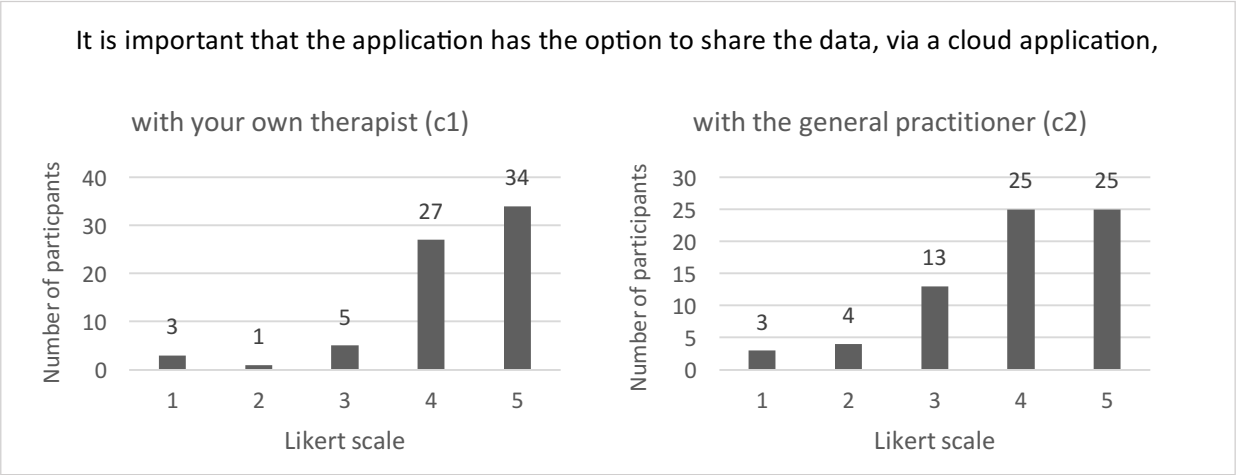
*Data visualisation and data availability*




*Note. Likert scale data*

**Figure 10**

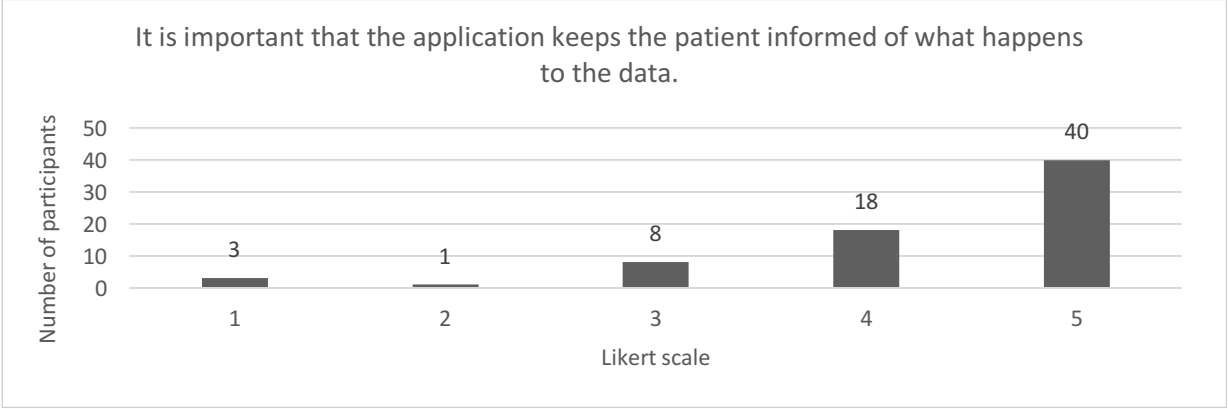
*A cloud application*




*Note. Likert scale data*

**Figure 11**

*Patient informed*




*Note. Likert scale data*

**Visualized data**

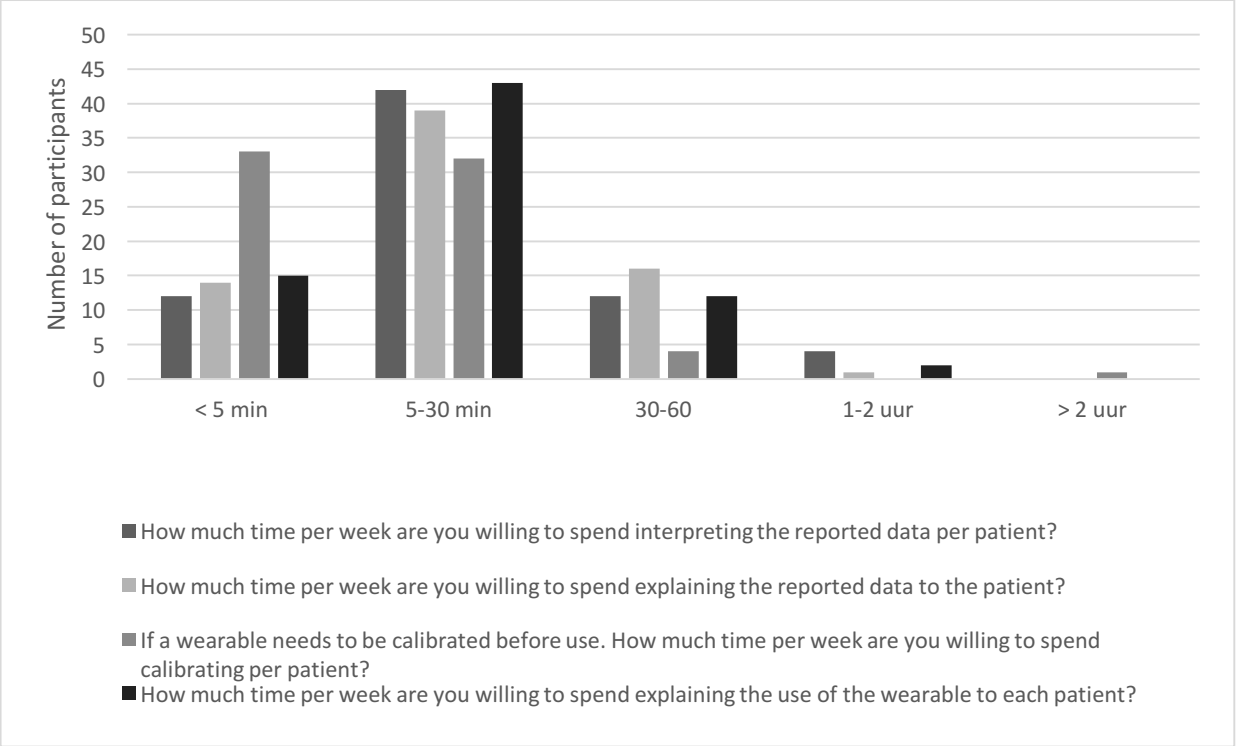
The available data of a patient can be compared in various ways. Data can be compared with the gold standard, which is often used in diagnostic testing. However, the gold standard is not available for all parameters. 52.85% of our participants considered it important to visualize the obtained data compared to the gold standard. In addition, data can also be compared to the individual's own pre-measurements. 87.14% of the participants found it important to visualize the pre and post results. The participants thus suggest that app developers and product designers should make sure that the data is compared with patients' own pre- and post-measurements rather than with the gold standard.

**Data interpretation and reporting: Time**

Healthcare professionals' willingness to invest time in using a wearable device should be taken into account by app developers and product designers. When using a wearable, therapists will need to spend time interpreting and calibrating the data, explaining the wearable and the obtained data to the patient. Interpreting and calibrating data will likely occur outside of therapy time. Most healthcare providers would spend between 5 and 30 minutes interpreting the obtained data per patient and would spend less than 5 minutes calibrating the data. Explaining the wearable and interpreting the data to the patient will likely occur during the therapy session, with most healthcare professionals spending between 5 and 30 minutes on each task. App developers and product designers must take this into account to ensure that the application is user-friendly enough that healthcare professionals do not have to spend more time calibrating and interpreting data than the values indicated above. More details on this can be found in Figure 12.

**Figure 12**

*Willingness to spent time*



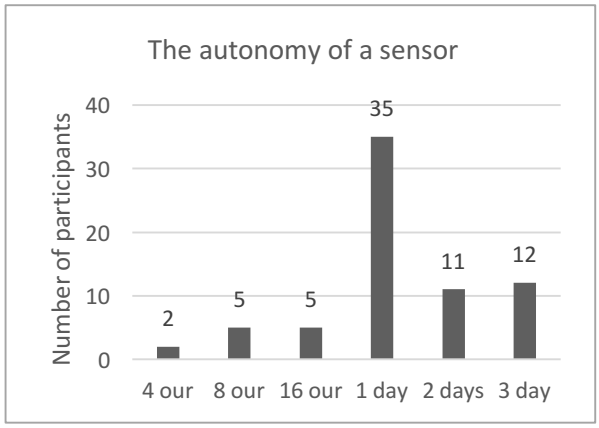
## Energy consumption

### Autonomy of a sensor

When a sensor's battery runs out too quickly, the therapist will have to recharge it between therapy sessions. The results reflect that only a small percentage of participants agreed that the sensor's battery should last less than one day. When designing a sensor, it is recommended to design a battery that will last at least one day. More details see Figure 13.

**Figure 13**

*Autonomy of a sensor*

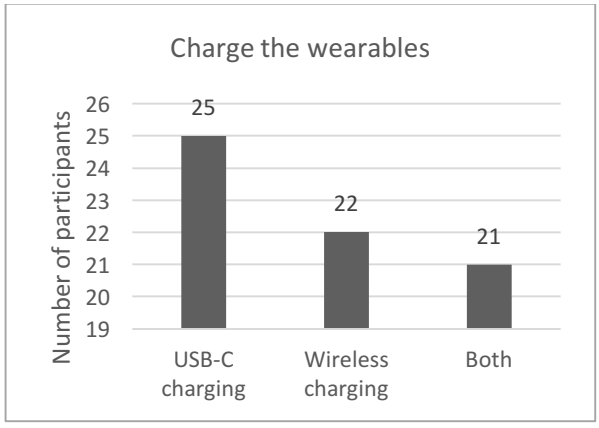



### Charging wearables

Of the participants, over 65% expressed a preference for charging via the USB-C port, while just over 60% chose wireless charging for mobile devices. Most participants preferred both USB-C and wireless charging for their wearables. For more details, refer to figure 14.

**Figure 14**

*Charge the wearables*



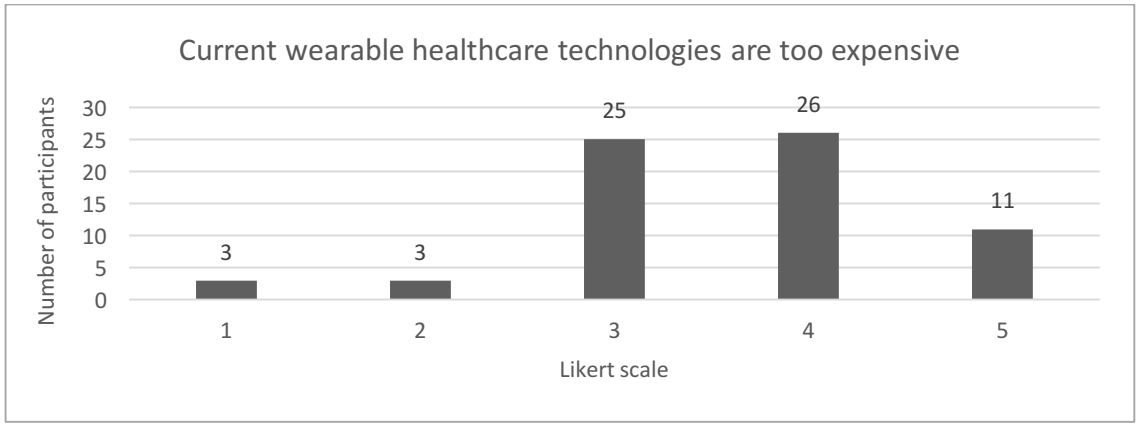
## Willingness to pay

It is essential for wearables developers and product designers to be aware of the users' willingness to pay and the demand for them in the market place. Moreover, the reimbursement factor is also a crucial consideration. Therefore, developers and product designers must take these aspects into account while creating the business model for a specific application or sensor. Understanding the cost of wearables and their financial viability is necessary for ensuring the successful implementation of these technologies. Developers and designers must assess the target audience's willingness to pay and identify the specific cost elements of wearable devices that influence the overall cost.

More details can be found in Figure 15.

**Figure 15**

*Expensive wearables*



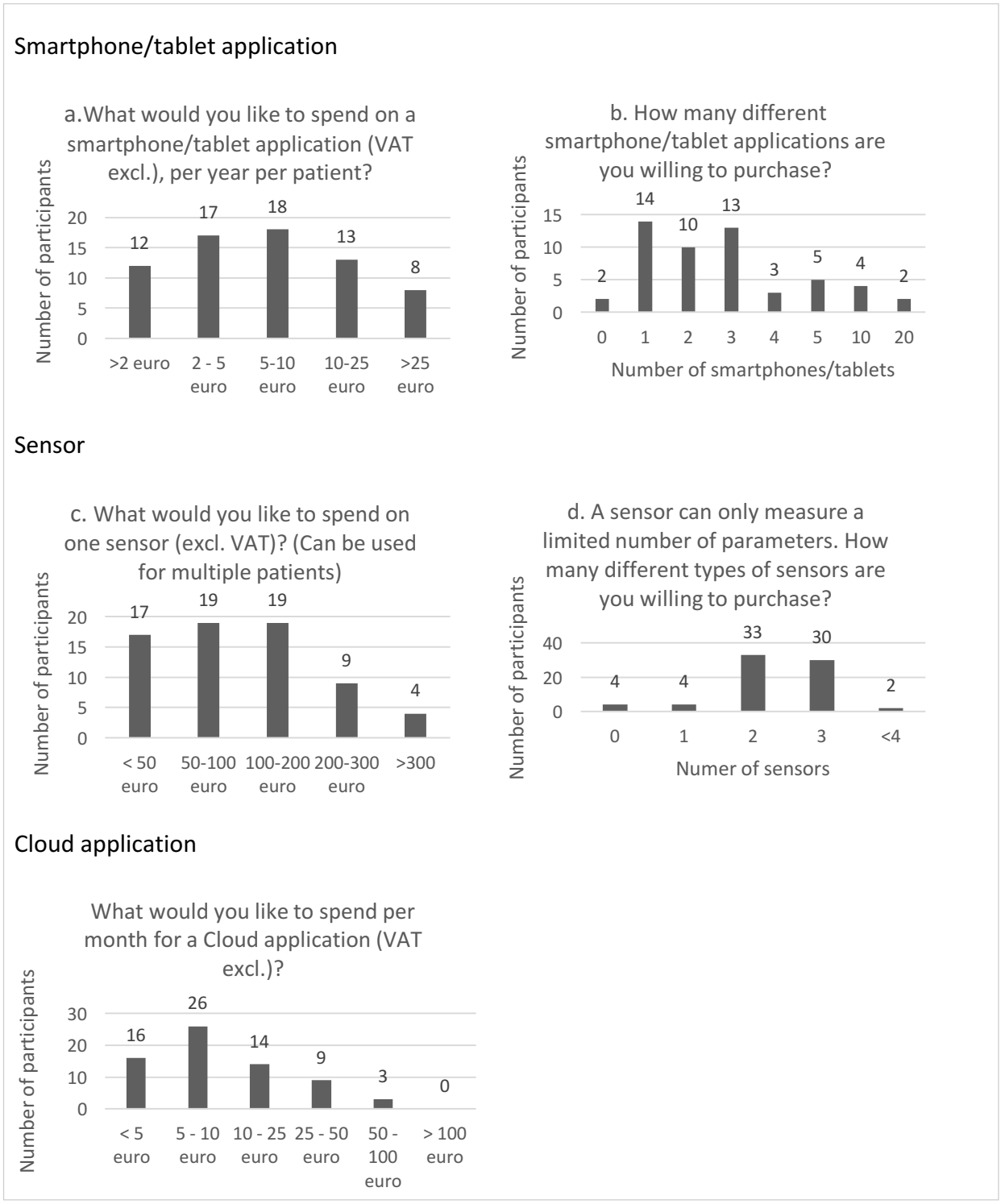

*Note. Likert scale data*

There are many free health apps available on the market that track various parameters, such as weight, number of steps, heart rate, BMI, and etcetera. When designing a wearable system, it is essential to consider the amount healthcare providers are willing to spend. The amount participants are willing to spend per year for an application varies widely and probably depends on the type of application. Furthermore, the number of applications a health care professional intends to purchase also varies greatly, with most not wanting more than three. For the sensor, most participants are willing to pay no more than 200 euros and purchase maximum 3 sensors. Finally, participants were asked to indicate how much money they would be prepared to pay for a cloud application. Most participants indicated that they would spend

between 5 and 25 euros. For more information on the potential cost of an application, sensor or cloud application, see Figure 16.

**Figure 16**

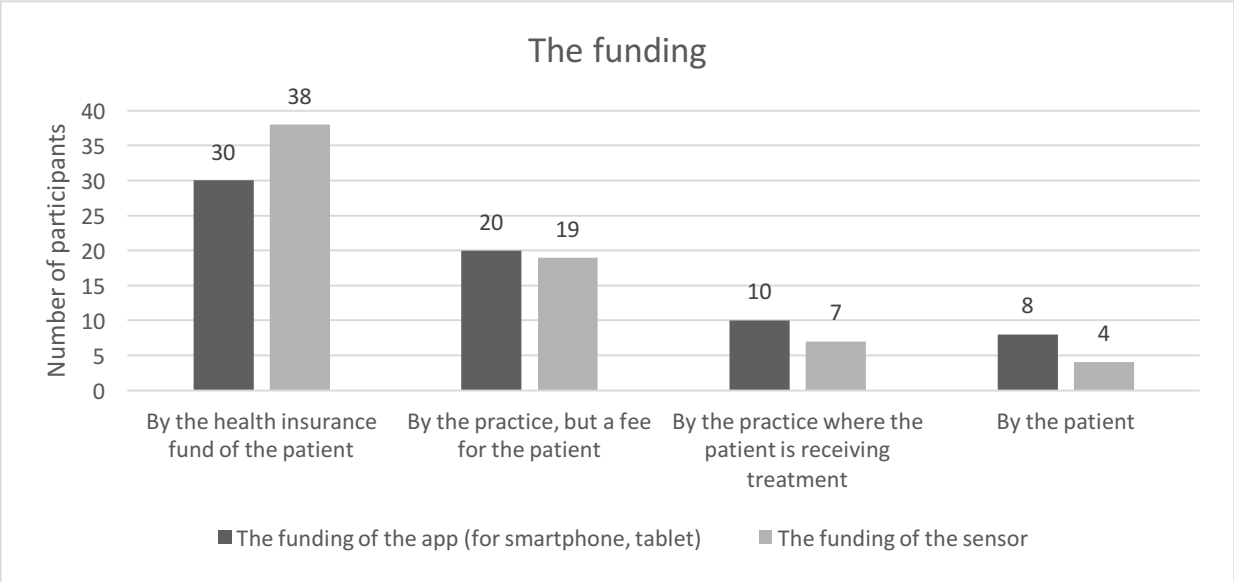
*Willingness to pay and willingness to purchase wearables*



There is an added value when app- developers and product designers create a wearable that is reimbursed by the patient's health insurance. According to our participants, the patient's health insurance should reimburse both the application and the sensor. See Figure 17 for more information on sensor or application funding.

**Figure 17**

*The funding of het app/sensor*




A cloud application can be connected to various smartphone/tablet applications and sensors. Users can get a comprehensive picture of their health by integrating different applications and sensors. For example, an application that measures heart rate can be linked to a sensor that measures blood pressure; this data can also be linked to activity levels and sleep patterns to get a complete picture of the user's health. Most of the participants, namely 94.11% are interested in such a cloud application. Google Fit, Apple Health and Samsung Health are examples of these cloud applications.

## The use of wearables in exercise therapy

### Wearables as a supplement to conventional therapy

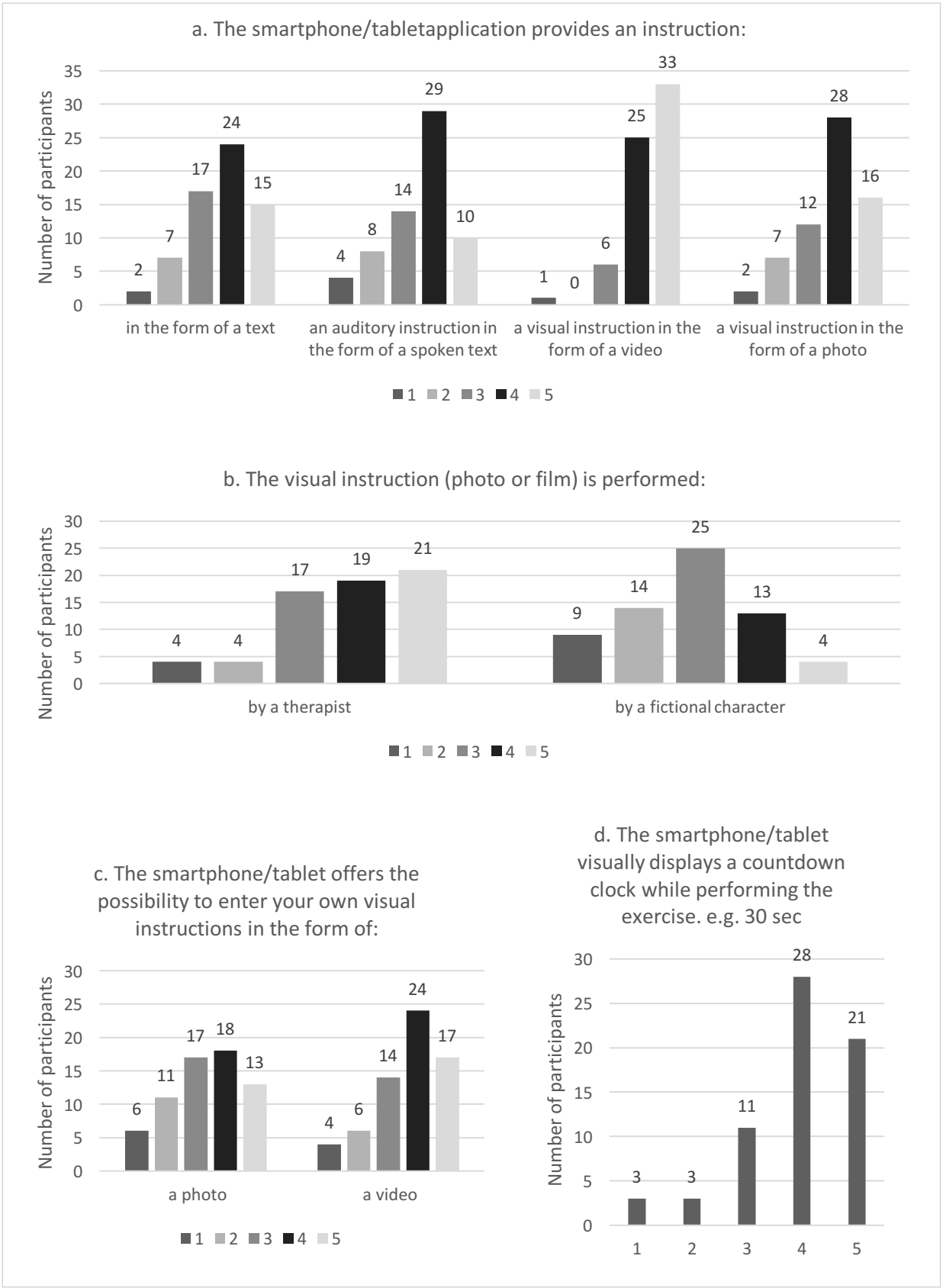
Healthcare professionals prefer to utilize wearables as a complementary tool to conventional therapy rather than a substitute for it. 98.5% of health care professionals agree with this statement.

### Instructions in an application

Instructions within an application can be conveyed in multiple ways, including text, spoken text, video, or photo. All forms of instructions are regarded as essential. However, participants highlighted that video instructions offer particular added value when incorporated into an application. Additionally, the other three methods of providing instructions are also deemed relevant, according to the participants. For instance, auditory instructions in the form of spoken text can be advantageous for individuals with visual impairments. A visual instruction in a health application can be presented in various ways. Firstly, it can be created by the therapist themselves, for example, by recording a video in which the therapist demonstrates and explains the exercise, or by taking a photo to demonstrate correct body posture during an exercise. Secondly, another option is the use of a fictional character in the instructions, for example, through animations or illustrations. Participants expressed a preference for visual instructions provided by the therapist themselves. This means that when developing an application, it is advisable to keep an option available to add a visual instruction from the therapist to an exercise. A health application that supports importing photos or videos to provide instructions on exercises can be very useful for users who prefer visual aids to understand how to perform an exercise correctly. With this feature, therapists, for example, can film the patient while performing an exercise correctly, and the patient can review the video at home afterwards. In addition, this feature can also be used to track a patient's progress by comparing previous recordings. Finally, when developing an application, healthcare professionals are expected to have a countdown timer when performing exercises. A countdown timer can be helpful so the user can see when their exercise is finished. Further details can be found in figure 18.

**Figure 18**

*Instructions*

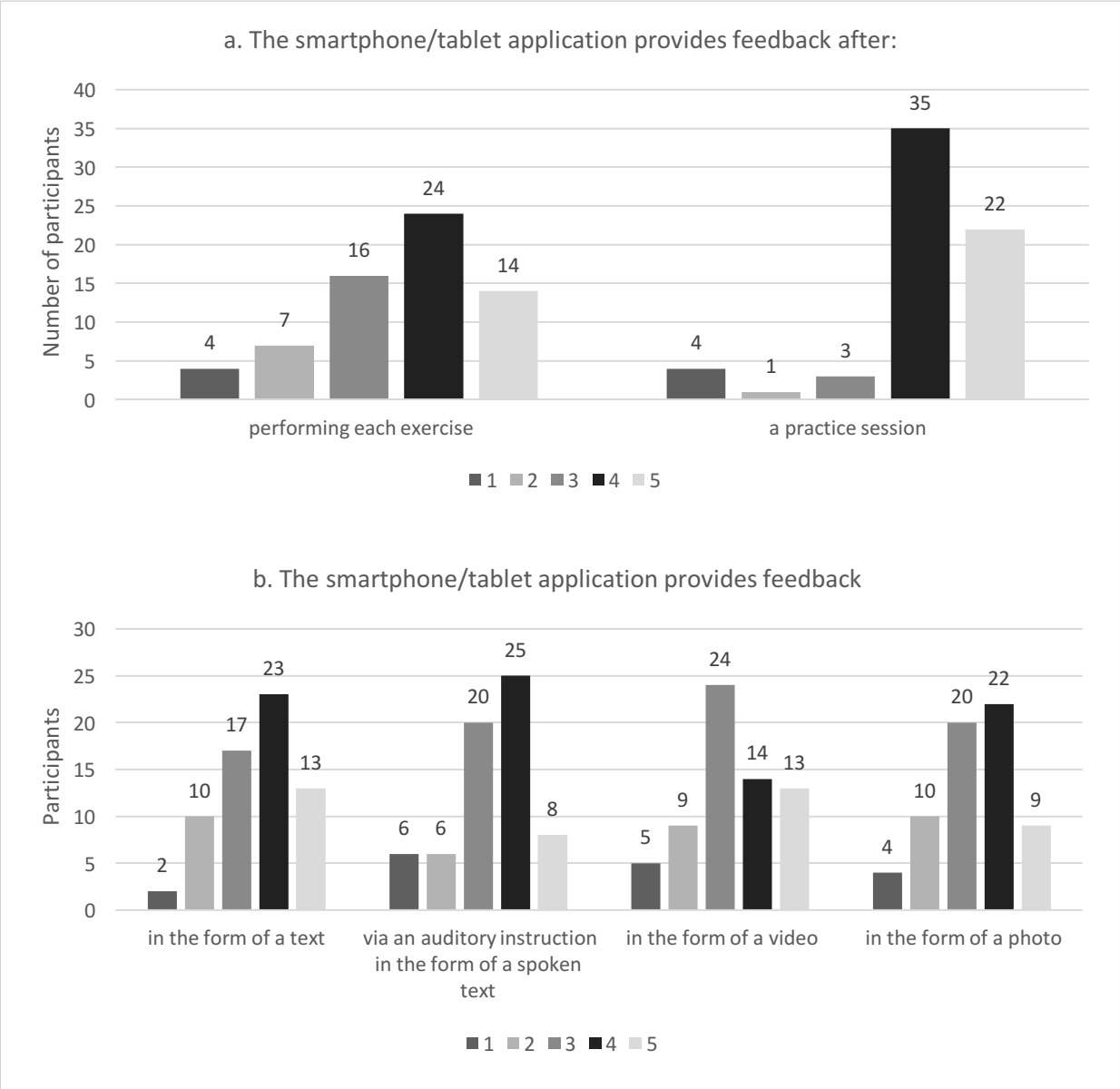


**Feedback in an application**

App developers should ensure that feedback is given after a complete practice session, based on the responses of the participants, rather than after each exercise. This is further elaborated in Figure 19a. Feedback can play a vital role in helping users make progress, and following a complete session, it can take the form of a session overview. When providing feedback in an application, it is best for developers to use textual feedback. Textual feedback, such as suggestions for improvement, may be effective. According to participants, spoken text in the form of a video or photo can provide benefits. Spoken feedback can be beneficial for individuals who struggle with reading text, while visual feedback, such as photos and videos, can help users improve their movements by following the visual example. Further details on the importance of the different forms of feedback as perceived by the participants can be found in Figure 19b.

**Figure 19**

*Feedback*

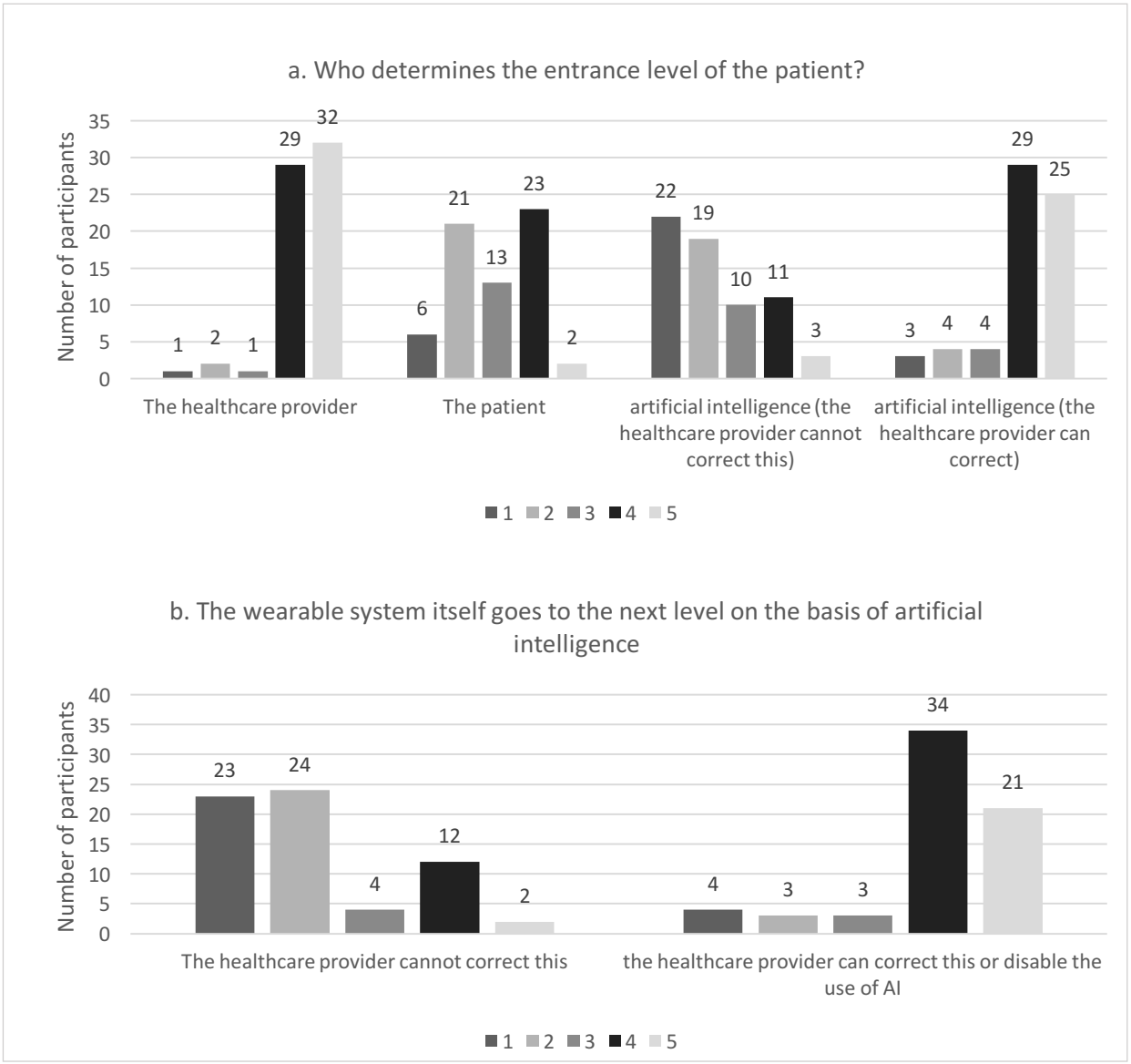


**Goals and level determination**

When designing an application, it is crucial to take into account at what level a patient should start training. There are multiple ways to determine this level. One possible approach is for a care provider to assess the level themselves, taking into account factors such as the patient's medical history and physical condition. It is perceived as important by participants that the healthcare provider can set the level. Another method is for the patient to determine the level based on their own experience with exercises. This approach allows the patient to adjust the level according to their individual comfort. Participants had mixed opinions about this method. AI can also be used to determine the level of the patient's exercises. In that case, there are pre-set parameters on which exercise suggestions are made. This approach offers comparatively less flexibility compared to when a caregiver or patient adjusts the level. Only a few participants agree with this method of level determination. Finally, there exists a method that uses AI, but where health care providers can adjust the level themselves. A majority of healthcare professionals agree with this method. Based on the above findings, we recommend that app developers let the healthcare professional determine the level of exercise with or without the use of AI. A wearable system can sometimes progress to the next level autonomously by utilizing AI. For example, a wearable system that measures physical activity of a user such as heart rate and number of steps. This is then utilized to determine the level of training. When AI is used, there can be an option for healthcare professionals to adjust the level if needed. AI can serve as a valuable tool by providing a solid starting point for determining the level of exercises based on patient input and collected data. However, the expertise and judgment of healthcare professionals are essential in fine-tuning the level to align with the specific needs and preferences of each patient. This approach facilitates a more personalized treatment, which has the potential to enhance the effectiveness of the overall treatment. Furthermore, adjusting the level by the healthcare professional can instil more confidence in the patient as they feel supported by an expert healthcare provider who is involved in their recovery. The results suggest that when designing a wearable application that uses AI for level determination, it is important to provide the healthcare professional with the option to manually advance the patient to the next level. Further details regarding this can be found in Figure 20.

**Figure 20**

*Goals and level of determination*

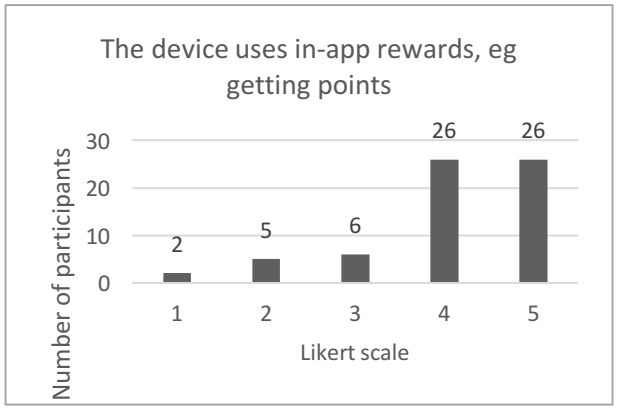


### Motivational aspect in an application

A feature that can be included in an application is in-app rewards. This can encourage users to achieve their health objectives. According to the responses of the participants, in-app rewards should definitely be included as a feature in an application. For more information, refer to figure 21.

**Figure 21**

*In app rewards*




*Note. Likert scale data*

## Open questions

### The use of wearables in practice

Participants were asked whether they had already used wearable technology in their practice. A minority of healthcare professionals (20%) utilize wearable technology. Producers should consider promoting wearable systems to increase their use in the workplace. Several reasons why healthcare professionals have not yet adopted wearable technology are as follows: the high cost, the time-consuming nature of implementation, personal lack of technological proficiency, limited availability of user-friendly and affordable devices, and the complexity of wearable systems. Among the 20% who use wearables, for example, physiotherapists emphasize the ability to track the number of steps patients take to motivate them to engage in more physical activity. On the other hand, nurses highlight the use of wearables during dialysis to access or input dialysis data through an application. Additionally, nurses also maintain patient records in an application for capturing wound photos and ensuring effective monitoring of patient progress.

**Advantages and/or disadvantages of using artificial intelligence in healthcare technology**

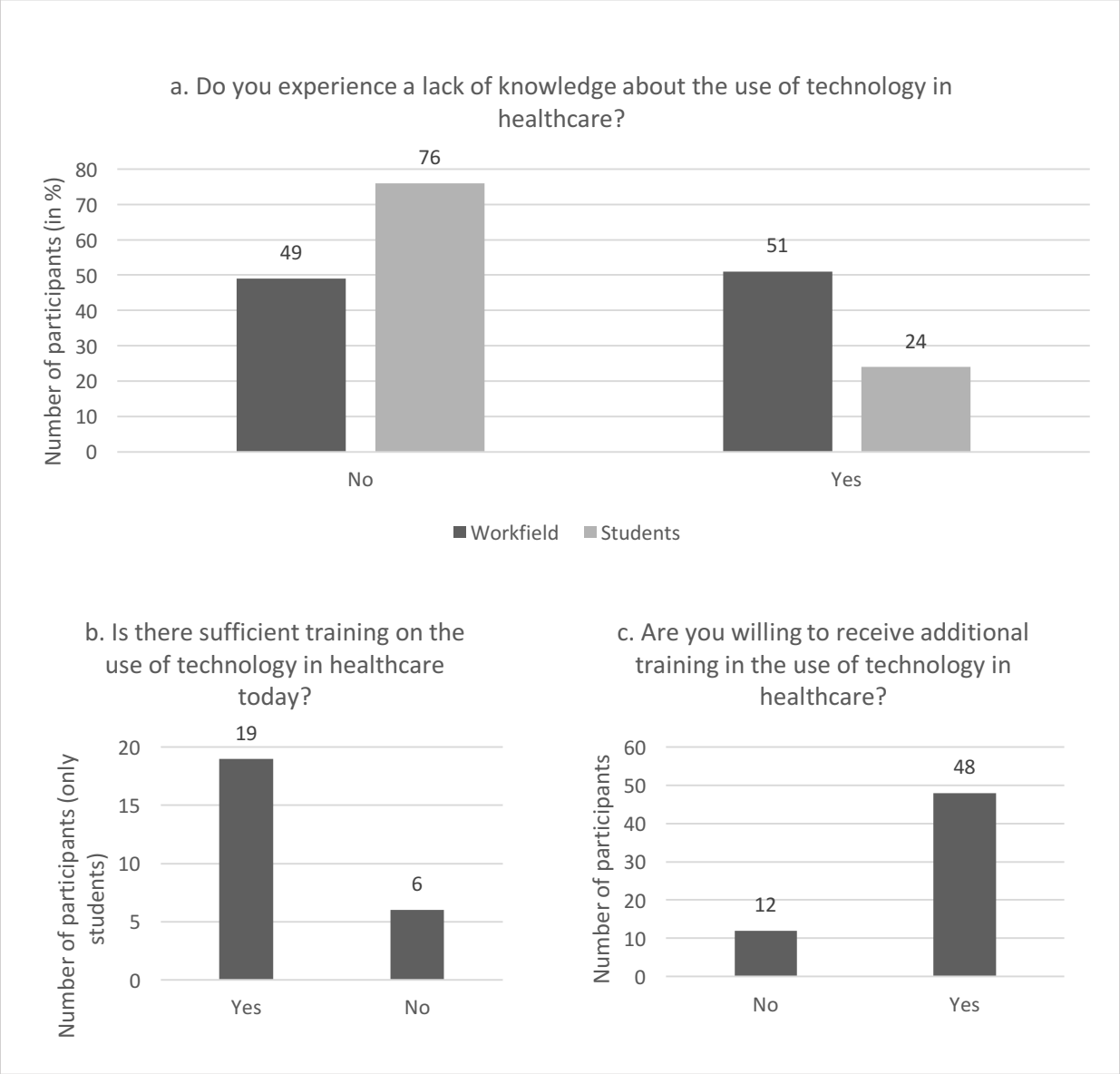
According to healthcare professionals, some benefits of using artificial intelligence (AI) in healthcare technology include reduced caregiver workload. AI allows them to take on more of an evaluative role. In addition, AI allows for a more individualized approach to patient care, and the data generated is objective. On the other hand, the drawbacks raised by healthcare providers revolve around ethical privacy concerns. One could question whether the use of AI adequately respects patient privacy. Moreover, a physical therapist emphasizes that AI should never replace a therapist's common sense and expertise. They emphasized the importance of critical thinking among physical therapists because technology can sometimes provide incorrect or faulty information.

## Education

Healthcare professionals can only purchase wearables with sufficient information and knowledge about current technology. Manufacturers of wearables could give lectures on their particular product, or educational institutions could include technology in their curriculum. There is a significant discrepancy between the percentage of students and professionals reporting insufficient knowledge of technology. Specifically, 24% of students experience a lack of knowledge in this area, while 76% of professionals do. Notably, 79% of students feel they receive adequate education on the use of technology. Still, 80% of participants indicated they would like to take additional training on the use of technology in healthcare. See Figure 22 for more information.

**Figure 22**

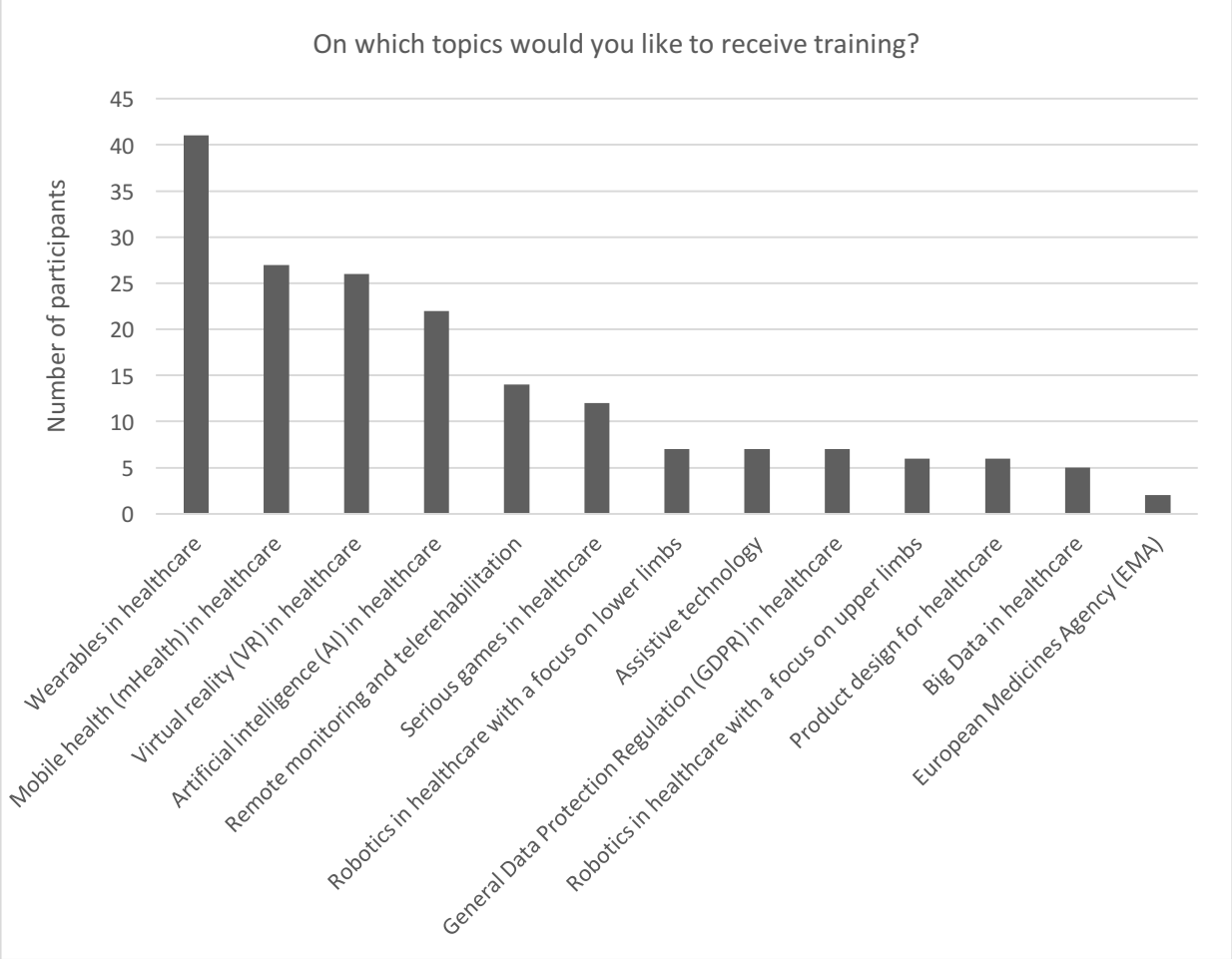
*Knowledge of technology*




Healthcare professionals can expand their knowledge and skills with educational courses. The two most popular training programs among participants are "Wearables in Healthcare" and "Mobile Health in Healthcare." The most popular courses are those that pertain to recent and new technologies. Figure 23 provides more detailed information on the training programs that healthcare professionals are interested in pursuing.

**Figure 23**

*Topics they would prefer to have lessons on*



# Discussion

## Interpreting Results

This study investigates which app and sensor features health professionals consider important in health-wearable devices to tailor future wearables to their needs. After analysing the results, a more critical view on the reviewed data and the limitations of the study is provided in this section. Finally, suggestions for a follow-up study is discussed.

#### General information about the participants

Looking at the general information about the participants, it is clear that a large proportion (43.66%) of the participants are students. It is crucial to be aware of this statistic while interpreting the results to avoid potential sample size bias. Technology in healthcare is relatively new and constantly evolving (Peng et al., 2022). Students may view technology, and thus wearables, differently since technology has always been present in their lives. Individuals who graduated from their studies some time ago may also not have received comparable levels of technological education. However, this has not yet been investigated. Therefore, it is crucial to be aware of this statistic while interpreting the results to mitigate potential sample size bias.

#### The use of wearables

One aspect of wearable devices that has to be ensured when making a device is data security. It is expected that as wearables collect and store personal health information, ensuring the privacy and protection of user data is often seen as an important factor. However, in this survey-study, it is remarkable that the opinions of most participants are neutral on this issue. Why they remain neutral around this has not been questioned in the study. The participants' limited understanding of the importance of data protection in relation to privacy laws and their potential implications should be taken into account. Another notable feature commonly found in contemporary wearable devices is the integration of chat functions within applications, enabling communication between patients and healthcare professionals. This feature allows users to receive personalized guidance, feedback, and support in real-time. More than half of the participants expressed their interest in having this feature included in the application. This feature has demonstrated potential for demand within the wearable

market, highlighting actionable opportunities for app developers to capitalize on. The comfort of wearing wearable sensors is an undeniable important quality according to the participants, almost all participants (59) indicated that they felt comfort of the sensor is very important. They may think that it can significantly impact user experience and adherence. Uncomfortable or inconvenient devices could possibly discourage users from wearing them consistently. For example, it is anticipated that wearable electronics, which integrate the comfort and appearance of conventional clothing with the functions of electronic devices, will play an important role in remote health monitoring (Y. Zhang et al., 2021). According to our results, it is clear that wearable design should prioritize comfort when developing new wearables. Determining the location for wearing wearables is crucial to capture accurate and reliable data. Therefore, it is important to know in which location healthcare professionals would like to use the wearables. We can see that opinions are divided (Fig. 6). Possibly this needs further investigation to go deeper into the issue. Along the other hand, the makers could take this into account and develop a wearable that can be easily transported from home to the practice and vice versa. Additionally, a secure case can be useful for the transportation of the wearable to prevent damage.

**Target group**

When we look at the results on what target groups are relevant to develop an application for (fig. 7) it is observed that healthcare professionals in this study see obesity as the most important target group, but measuring BMI and body fat are less relevant to them. From this, we may conclude that healthcare professionals do consider it important to monitor obesity, but they want to do so using other parameters. For example, they find it relevant to monitor the number of daily steps or physical activity levels. The target groups for wearables consider tinnitus (15.27%) and hearing loss (16.66%) to be less important. This may possibly be due to health care professionals being less familiar with them. Additionally, Rheumatoid Arthritis (31.94%) and arthrosis (30.55%) are perceived as less important target groups. However, evidence exists in other studies that an application would enhance self-management in people with Rheumatoid Arthritis. (Srikesevan et al.) Moreover, the use of technology to provide exercise programs for patients with knee osteoarthritis appears to offer benefits. (Chen et al.) About half of the participants (47.22%) considered healthy individuals without any conditions as a target group for wearables. However, older adults (65.27%) with potentially less

knowledge about wearable use are also perceived as an important target group by the participants. The primary target groups identified are obesity (83.33%) and type 1 and 2 diabetes (81.94%).

**Data**

These findings align with a recent study, which provided evidence that the utilization of wearables can effectively contribute to the mitigation of hyperglycaemia in individuals diagnosed with diabetes (Grady et al.). Interestingly, when we look at the results on what parameters are relevant to develop an application for (fig. 7) spatiotemporal parameters are considered the least important by the participants, yet some physiotherapists indicated distance, speed, cadence, step length, and step width as additional parameters. This is possibly because the term 'spatio-temporal parameters' was too vague and generic and the participants wanted to be more specific. It is clear that the vast majority of the participants want to be able to easily transfer the data to spreadsheet software and they would like a visualization of the various parameters. This seems to indicate that healthcare professionals want to be able to read and interpret the data easily so they conveniently communicate the results to their patients. Considering that many participants express the importance of sharing information with both their own therapist and general practitioner, integrating a feature into an application that facilitates this information sharing would certainly provide added value. (Fig. 10). It appears to be crucial when creating an application to inform patients about the use of their data. This consideration should be taken into account in the development process (Fig.11).

**Energy consumption**

Looking at the results about the autonomy of the sensor's battery, there is a majority of individuals choose a 1-day battery. This is a clear opinion that can certainly help in the future development of wearables. This is an expected response, as it is simply inconvenient and unsatisfactory if the battery does not last during the working day. Researchers are working on future batteries for wearables on multiple aspects such as energy density, mechanical flexibility and safety. (Wang et al., 2022). Most participants preferred both USB-C and wireless charging for their wearables. When designing a wearable, it is recommended to offer both the option, according to the participants (Fig. 14).

**Willingness to pay**

Current wearable healthcare technologies are too expensive to purchase according to majority of the participants of this study. They perceive current healthcare technologies as prohibitively expensive, which may deter them from purchasing the technology. This presents both an opportunity and a challenge for app developers and product designers to offer more affordable wearables, thereby addressing an untapped market niche. Opinions among participants regarding their willingness to invest in smartphone/tablet applications, sensors, and cloud applications are divided. This division may be due to the lack of knowledge about the price of such products. It should also be remembered that many participants are still students and may not know how much they can spend on these smartphone/tablet applications, sensors and cloud applications. The results of this sections seem not quite definite yet.

**The use of wearables in exercise therapy**

The majority of healthcare professionals in this study want to use wearables as a supplement to conventional therapy rather than a replacement. This is as expected as there has been research on the ethical implications of AI. It is stated that AI could provide some significant benefits in the field, but there remain some ethical concerns (Fiske et al., 2019). The findings in this study may paint the picture that new technological developments in the clinical area will not threaten the role of physiotherapists. However, this still needs to be confirmed. When designing the application, we may assume it is essential to consider that the therapist can still

provide their input to the therapy via the application and not rely solely on the application to deliver the entire treatment.

**Open questions**

A minority of healthcare providers use wearables in their practice. This is in line with previous research, as it has been studied that application adoption among healthcare end users is very low. Healthcare professionals face significant challenges in successfully implementing apps for providing healthcare services (Al-Rawashdeh et al., 2022). Several explanations appeared from the responses to this open-ended question. For example, it can be challenging to stay on top of the latest developments as it is claimed that it requires the support of peers and good organization to successfully implement new technology, along with other factors (Konttila et al., 2019). Practitioners may not always understand if they can trust these technologies and how to use them effectively to improve their patient's health (Tomasella & Morgan, 2021). This emphasizes the need for initiatives to promote the utilization of wearables as a means to enhance the efficiency and convenience of healthcare workers' tasks.

**Education**

Many participants report a lack of knowledge on the use of wearables in healthcare. Significantly more professionals with field experience report this lack of knowledge. It is essential that education includes knowledge of the use of wearables to ensure that healthcare professionals are aware of the possibilities and limitations of these technologies. This can contribute to better implementation of wearables in practice and therefore leading to improved patient health outcomes. The students who responded to this question were generally satisfied with their knowledge and training. This could indirectly mean that the school system is doing a good job in providing this knowledge and training on the use of wearables in healthcare, but this has yet to be confirmed.

## Limitations of Study

Several limitations must be recognized. First, participant characteristics present a potential bias in interpreting the data. There are many students within the group of participants, and most health professionals who graduated did so after 2010. Consequently, only 15 of the 72 participants have more than 15 years of field experience. This affects whether or not they use wearables in their practice (Fig.17). Most respondents reported that they had not yet integrated wearables into their practice. A second reason to be careful in interpreting the results is that more physical therapists than other healthcare providers participated in the survey. This may affect some questions, as in Figure 7, about whether the data should be shared with the physical therapist or the patient's primary care physician. Second, we do not know the variation in the study population, and the results cannot be generalized to the broader population of health professionals. Consequently, this study cannot claim to be representative of the target population. Finally, the questionnaire should be shortened to increase response rates in future studies. This is necessary since many participants did not complete the questionnaire.

## Suggestions for Follow-up Study

Future research may continue on some of the themes already discussed, whose results were surprising or not yet thoroughly understood enough. For instance, it is a surprise that health professionals didn't think data protection was necessary, as they were relatively neutral on the fact, and this could certainly be explored better. As it may be important to know why they think it isn’t as important and whether these results can be generalised for a bigger population. Additionally, further research could dive deeper into the needs of the participants and could look at the chat function in wearables, as more than half of the health professionals thought it would be a helpful feature. Exactly how they want to see the function implemented, how they want to use it, and whether this is all possible with the wearables now available is yet to be further explored. Furthermore, much information was gathered about the type of feedback provided by wearables. However, a qualitative study on this topic can ensure that we get a better idea about what exactly is needed in this area so we can better tailor future wearables. Finally, it would be valuable if qualitative research can be done to understand the perspectives of health professionals on wearables. This would show u a broader view on the

barriers they may face and which factors encourage them to adopt them in their practice. By conducting further research in this area, we can optimize the effectiveness of wearables by tailoring them to the specific needs and preferences of health professionals.

## Conclusion

This study provides valuable insights to app developers and product designers. By answering the research question, it offers a clearer understanding of the needs of healthcare professionals. The study highlights important information about wearable features, including usage patterns, relevant target populations, energy consumption, costs, utilization during therapy, and educational aspects of current therapeutic practices. It was found that key features such as in-app rewards, clear data visualization, and sensor comfort level must be taken into consideration by manufacturers. Additionally, wearable systems should be designed for use during therapy and at home. Furthermore, using visual instructions can enhance the effectiveness of wearable systems. Finally, better education and training are needed to ensure that health professionals can fully utilize the potential benefits of wearables in patient care. As a result, these findings may enable wearables development to be better tailored to the needs of health professionals in a clinical context and provide a basis for further research in this area.

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Appendix A: questionnaire

# Wearables

Start of Block: Default Question Block

Inleiding **Wearables: wat vindt de zorgprofessional belangrijk?**
Wearables u kent ze wel. Het zijn draagbare elektronische apparaten die op het lichaam gedragen worden en informatie verzamelen over het menselijk lichaam. Typische voorbeelden zijn: activity trackers, smart watches, hartslagmeters en biosensors. De afgelopen jaren zijn deze wearables steeds populairder geworden, ook bij patiënten binnen de gezondheidszorg. **Via deze vragenlijst willen we nagaan aan welke eisen een wearable moet voldoen voor het gebruik in de zorg.**

De vragenlijst zal 10 tot 15 minuten van uw tijd vragen, is altijd vrijblijvend en anoniem.

Alvast bedankt voor uw deelname.

*Deze vragenlijst is opgesteld door de studenten van de Faculteit Revalidatiewetenschappen, Universiteit Hasselt, in samenwerking met de Karel de Grote Hogeschool, Antwerpen, in kader van het PWO project 'Machine Learning at the Extreme Edge', De resultaten van deze bevraging zullen verwerkt worden door de laatstejaarsstudenten van de Faculteit Revalidatiewetenschappen, Universiteit Hasselt, in kader van hun masterproef.*

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ALGEMEEN **1/9 - ALGEMEEN.**

Q1 **Wat is uw zorgberoep?**

- ○ Kinesitherapeut (1)
- ○ Ergotherapeut (2)
- ○ Huisarts (3)
- ○ Arts, specialisatie: (4) _____
- ○ Ander zorgberoep: (5) _____
- ○ Student, vermeld uw opleiding en hogeschool of universiteit: (6) _____
- ○ Geen zorgberoep (vermeld uw beroep): (7) _____

Q2 **Wat is uw afstudeerjaar?**

_____

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GEBRUIK **2/9 - HET GEBRUIK VAN WEARABLES.**

Q3 Geef voor onderstaande stellingen aan in hoeverre u het hiermee eens bent.
1= volledig mee oneens

2= deels mee oneens
3= neutraal
4= deels mee eens
5= volledig mee eens

| | 1 (1) | 2 (2) | 3 (3) | 4 (4) | 5 (5) |
|---|---|---|---|---|---|
| Het gebruik van een wearables kan bijdragen tot een verbeterde patiëntenzorg en follow-up. (1) | ○ | ○ | ○ | ○ | ○ |
| Het gebruik van een wearable heeft een positieve invloed op de therapeut-patiënt relatie. (2) | ○ | ○ | ○ | ○ | ○ |
| De wearable houdt rekening met de gegevensbescherming. (3) | ○ | ○ | ○ | ○ | ○ |
| De wearable is voldoende beveiligd. (6) | ○ | ○ | ○ | ○ | ○ |

Q4 Geef voor onderstaande stellingen aan in hoeverre u het hiermee eens bent.
1= volledig mee oneens
2= deels mee oneens
3= neutraal
4= deels mee eens
5= volledig mee eens

| | 1 (1) | 2 (2) | 3 (3) | 4 (4) | 5 (5) |
|---|---|---|---|---|---|
| De applicatie op het device (smartphone, tablet) verleent toegang tot communicatie met zorgverleners via een chatfunctie. (1) | ○ | ○ | ○ | ○ | ○ |
| De dimensie van de sensor (sensor = device geplaatst op het lichaam) heeft een belangrijke invloed op het al dan niet gebruik ervan in de klinische praktijk. (2) | ○ | ○ | ○ | ○ | ○ |
| Het is belangrijk dat de sensor (sensor = device geplaatst op het lichaam) comfortabel is in het gebruik voor de patiënt. (3) | ○ | ○ | ○ | ○ | ○ |

Q5 **Waar gaat uw voorkeur uit in het gebruik van een wearable?**
Meerdere antwoorden mogelijk.

- ☐ Gebruik van wearable als thuismonitorapparaat. (1)
- ☐ Gebruik van wearable tijdens therapiesessies. (2)

Q6 **Hoeveel tijd per week bent u bereid te spenderen aan het geven van uitleg over het gebruik van de wearable per patiënt?**

- ○ <5 min (1)
- ○ 5-30 min (2)
- ○ 30-60 min (3)
- ○ 1-2 uur (4)
- ○ >2 uur (5)

Page Break

DOELGROEP **3/9 - DOELGROEP**

Q7 **Kruis aan voor welke doelgroep u het relevant zou vinden om een wearable te ontwikkelen.**
Meerdere antwoorden zijn mogelijk.

- ☐ Gezonde populatie (1)
- ☐ Overgewicht (2)
- ☐ Diabetes type 1 & type 2 (3)
- ☐ Artrose (4)
- ☐ Hypertensie (5)
- ☐ Epilepsie (6)
- ☐ Zwangere vrouwen (7)
- ☐ Beroerte (CVA) (8)
- ☐ Chronische lage rugpijn (9)
- ☐ Chronisch luchtwegaandoening (10)
- ☐ Reumatoïde artritis (11)
- ☐ Ouderen (12)
- ☐ MSK-aandoeningen (13)
- ☐ Tinnitus (14)
- ☐ Gehoorverlies (15)
- ☐ Andere: (16) _____

DATA **4/9 - DATA**

Q8 **Kruis aan welke parameters u belangrijk vindt dat het wearable systeem monitort bij uw patiënt.** Meerdere antwoorden zijn mogelijk.

- [ ] Lichaamsvet (1)
- [ ] Lichaamsgewicht (2)
- [ ] BMI (3)
- [ ] Slaaphygiëne (4)
- [ ] Bloeddruk (5)
- [ ] Dagelijkse stappen (6)
- [ ] Hartslag (7)
- [ ] Type fysieke activiteit: bv stappen, lopen, fietsen, ... (8)
- [ ] Duur fysieke activiteit (9)
- [ ] Zittijd (10)
- [ ] Spatio-temporele gangparameters. Geef aan welke: (11) _____
- [ ] Andere: (12) _____

Q9 **Data visualisatie en data beschikbaarheid.**

Naast de wearable hebben we een mobile en/of cloud applicatie. Deze applicatie is verantwoordelijk voor de data storage en biedt de mogelijkheid de data te visualiseren. Via onderstaande vragen zouden we graag uw mening hebben omtrent de data visualisatie en data beschikbaarheid.

1= volledig mee oneens

2= deels mee oneens

3= neutraal
4= deels mee eens
5= volledig mee eens

| | 1 (1) | 2 (2) | 3 (3) | 4 (4) | 5 (5) |
|---|---|---|---|---|---|
| Het is belangrijk dat de applicatie een visualisatie (grafieken, tabellen, figuren,...) van de verschillende parameters bevat. (1) | ○ | ○ | ○ | ○ | ○ |
| Het is belangrijk dat de visualisatie opgeslagen kan worden in een Pdf-document. (2) | ○ | ○ | ○ | ○ | ○ |
| Het is belangrijk dat de applicatie de mogelijkheid heeft om de data te delen, via een cloudapplicatie, met de huisarts. (3) | ○ | ○ | ○ | ○ | ○ |
| Het is belangrijk dat de applicatie de mogelijkheid heeft om de data te delen, via een cloudapplicatie, met de eigen therapeut. (4) | ○ | ○ | ○ | ○ | ○ |
| Het is belangrijk dat de applicatie de patiënt op de hoogte houdt van wat er met zijn data gebeurt. (5) | ○ | ○ | ○ | ○ | ○ |
| Het is belangrijk dat de data beschikbaar is zodat deze aan de hand van spreadsheetsoftware verwerkt kan worden. (6) | ○ | ○ | ○ | ○ | ○ |

Q10 **Welke data dient er gevisualiseerd te worden in de applicatie?**
Meerdere antwoorden zijn mogelijk.

- [ ] Pre-post resultaten (1)
- [ ] Vergelijkingen met de gouden standaard (2)
- [ ] Normatieve data (3)
- [ ] Gefilterde data (4)
- [ ] Andere: (5) _____

Q11 **Data interpretatie en rapportering.**

| | < 5 min (1) | 5-30min (2) | 30-60min (3) | 1-2 uur (4) | >2 uur (5) |
|---|---|---|---|---|---|
| Hoeveel tijd per week bent u bereid te spenderen aan het interpreteren van de gerapporteerde data per patiënt? (1) | ○ | ○ | ○ | ○ | ○ |
| Hoeveel tijd per week bent u bereid te spenderen aan het geven van uitleg aan de patiënt over de gerapporteerde data? (2) | ○ | ○ | ○ | ○ | ○ |
| Indien een wearable voor gebruik gekalibreerd moet worden. Hoeveel tijd per week bent u bereid om te spenderen aan het kalibreren per patiënt? (3) | ○ | ○ | ○ | ○ | ○ |

Q12 **Duid de stelling aan waarmee u het meest akkoord gaat.**

- ◯ De gerapporteerde parameters van een apparaat dienen erg nauwkeurig te zijn, vooraleer ik het apparaat in gebruik zou nemen. (1)
- ◯ Gerapporteerde parameters op baseline niveau zijn voldoende, dit maakt de interpretatie ervan gemakkelijker. (2)
- ◯ Gerapporteerde parameters op baseline niveau zijn voldoende, dit maakt het apparaat patiëntvriendelijker. (3)

Page Break

ENERGIEVERBRUIK **5/9 - ENERGIEVERBRUIK**

Q13
In hoeverre bent u het eens met onderstaande stelling?
1= volledig mee oneens
2= deels mee oneens
3= neutraal
4= deels mee eens
5= volledig mee eens

| | 1 (1) | 2 (2) | 3 (3) | 4 (4) | 5 (5) |
|---|---|---|---|---|---|
| Energieverbruik (batterijduur) is een belangrijke factor bij het in gebruik nemen van de sensor (sensor = device geplaatst op het lichaam). (1) | ○ | ○ | ○ | ○ | ○ |

Q14 **De autonomie van een sensor (sensor = device geplaatst op het lichaam) is minimum:**

- ○ 4u (1)
- ○ 8u (2)
- ○ 16u (3)
- ○ 24u (1 dag) (4)
- ○ 48u (2 dagen) (5)
- ○ 72u (3 dagen) (6)

Q15 **Ik prefereer voor het opladen van de wearables.**
Meerdere antwoorden zijn mogelijk.

- ☐ Draadloos opladen. (1)
- ☐ Opladen via USB-C. (2)
- ☐ Andere: (3) _____

KOSTPRIJS **6/9 - KOSTPRIJS voor gebruik in de gezondheidszorg**

Q16 In hoeverre bent u het eens met onderstaande stelling?
1= volledig mee oneens
2= deels mee oneens
3= neutraal
4= deels mee eens
5= volledig mee eens

| | 1 (1) | 2 (2) | 3 (3) | 4 (4) | 5 (5) |
|---|---|---|---|---|---|
| De huidige draagbare technologie voor de gezondheidszorg zijn te duur om aan te kopen. (1) | ○ | ○ | ○ | ○ | ○ |

Q17 **Wat zou u als zorgverstrekker willen uitgeven voor een smartphone/tablet applicatie (BTW excl.), per jaar per patiënt?**

○ (1)

○ 2 ,- tot 5,- Euro (2)

○ 5,- tot 10,- Euro (3)

○ 10,- tot 25,- Euro (4)

○ > 25,- Euro (5)

Q18 **Hoeveel verschillende smartphone/tablet applicaties bent u bereid aan te kopen?**

_____

Q19 **Wat zou u als zorgverstrekker willen uitgeven voor één sensor (BTW excl.)? (Kan voor meerdere patiënten gebruikt worden)**

- ○ < 50,- Euro (1)
- ○ 50,- tot 100,- Euro (2)
- ○ 100,- tot 200,- Euro (3)
- ○ 200,- tot 300,- Euro (4)
- ○ > 300,- Euro (5)

Q20 **Een sensor kan maar een beperkt aantal parameters meten. Hoeveel verschillende type sensoren bent u bereidt aan te kopen?**

- ○ 0 (1)
- ○ 1 (2)
- ○ 2 (3)
- ○ 3 (4)
- ○ 4 (5)
- ○ meer dan 4 (6)

Q21 Duid de stelling aan waarmee u het meest akkoord gaat.

**De bekostiging van de sensor**

- ○ zou volledig bekostigd moeten worden door de praktijk waar de patiënt in behandeling is. (1)
- ○ zou volledig bekostigd moeten worden door de patiënt zelf. (2)
- ○ zou volledig bekostigd moeten worden door de praktijk waar de patiënt in behandeling is, maar de patiënt betaalt een vergoeding. (3)
- ○ zou bekostigd moeten worden door de mutualiteit van de patiënt. (4)

Q22 Duid de stelling aan waarmee u het meest akkoord gaat.

**De bekostiging van de app (voor smartphone, tablet)**

- ○ zou volledig bekostigd moeten worden door de praktijk waar de patiënt in behandeling is. (1)
- ○ zou volledig bekostigd moeten worden door de patiënt zelf. (2)
- ○ zou volledig bekostigd moeten worden door de praktijk waar de patiënt in behandeling is, maar de patiënt betaalt een vergoeding. (3)
- ○ zou bekostigd moeten worden door de mutualiteit van de patiënt. (4)

Q23 **Wat zou u als zorgverstrekker per maand willen uitgeven voor dergelijke Cloud applicatie (BTW excl.)?**

De applicatie biedt de zorgverstrekker de mogelijkheid de patiënten op te volgen en de data te visualiseren op een interactief dashboard. Deze visualisatie (alle figuren, tabellen, grafieken) kan men downloaden (bijvoorbeeld pdf-formaat).

- ○ < 5,- Euro (1)
- ○ 5,- tot 10,- Euro (2)
- ○ 10,- tot 25,- Euro (3)
- ○ 25,- tot 50,- Euro (4)
- ○ 50,- tot 100,- Euro (5)
- ○ > 100,- Euro (6)

Q24 **Geeft u de voorkeur aan één Cloud applicatie die gekoppeld kan worden aan de verschillende smartphone/tablet applicaties en sensoren.**

- ○ Ja (1)
- ○ Nee (2)

Page Break

OEFENTHERAPIE **7/9 - HET GEBRUIK VAN EEN WEARABLE IN DE OEFENTHERAPIE.**
Hierbij bedoelt men het gebruikt ervan tijdens of na een therapiesessie.

Q25 **Wearable systeem voor oefentherapie moet:**

- ○ aanvullend zijn aan klassieke oefentherapie. (1)
- ○ vervangend zijn voor klassieke oefentherapie. (2)

Q26
**a. Instructie.**
In welke mate vindt u onderstaande belangrijk?
1= niet belangrijk
2= grotendeels niet belangrijk
3= geen mening
4= belangrijk
5= zeer belangrijk

| | 1 (1) | 2 (2) | 3 (3) | 4 (4) | 5 (5) |
|---|---|---|---|---|---|
| De smartphone/tablet applicatie geeft een instructie in de vorm van een tekst. (1) | ○ | ○ | ○ | ○ | ○ |
| De smartphone/tablet applicatie geeft een auditieve instructie in de vorm van een ingesproken tekst. (2) | ○ | ○ | ○ | ○ | ○ |
| De smartphone/tablet applicatie geeft een visuele instructie in de vorm van een filmpje. (3) | ○ | ○ | ○ | ○ | ○ |
| De smartphone/tablet applicatie geeft een visuele instructie in de vorm van een foto. (4) | ○ | ○ | ○ | ○ | ○ |
| De visuele instructie (foto of film) wordt door een therapeut uitgevoerd. (5) | ○ | ○ | ○ | ○ | ○ |
| De visuele instructie (foto of film) wordt door een fictief karakter uitgevoerd. (6) | ○ | ○ | ○ | ○ | ○ |
| De smartphone/tablet biedt de mogelijkheid eigen visuele instructies in te voeren in de vorm van een foto. (7) | ○ | ○ | ○ | ○ | ○ |
| De smartphone/tablet biedt de mogelijkheid eigen visuele instructies in te voeren in de vorm van een video. (8) | ○ | ○ | ○ | ○ | ○ |

| | | | | | |
|---|---|---|---|---|---|
| De smartphone/tablet geeft visueel een aftelklok weer tijdens het uitvoeren van de oefening. bv nog 30 sec (9) | ○ | ○ | ○ | ○ | ○ |

Q27
**b. Feedback**

In welke mate vindt u onderstaande belangrijk?

1= niet belangrijk
2= grotendeels niet belangrijk
3= geen mening
4= belangrijk
5= zeer belangrijk

| | 1 (1) | 2 (2) | 3 (3) | 4 (4) | 5 (5) |
|---|---|---|---|---|---|
| De smartphone/tablet applicatie geeft feedback na het uitvoeren van elke oefening. (1) | ○ | ○ | ○ | ○ | ○ |
| De smartphone/tablet applicatie geeft feedback na een oefensessie. (2) | ○ | ○ | ○ | ○ | ○ |
| De smartphone/tablet applicatie geeft feedback in de vorm van een tekst. (3) | ○ | ○ | ○ | ○ | ○ |
| De smartphone/tablet applicatie feedback via een auditieve instructie in de vorm van een ingesproken tekst. (4) | ○ | ○ | ○ | ○ | ○ |
| De smartphone/tablet applicatie feedback in de vorm van een foto. (5) | ○ | ○ | ○ | ○ | ○ |
| De smartphone/tablet applicatie feedback in de vorm van een video. (6) | ○ | ○ | ○ | ○ | ○ |

Q28
**c. Doelen en niveaubepaling.**

In hoeverre bent u het eens met onderstaande?

1= volledig mee oneens
2= deels mee oneens
3= neutraal
4= deels mee eens
5= volledig mee eens

| | 1 (1) | 2 (2) | 3 (3) | 4 (4) | 5 (5) |
|---|---|---|---|---|---|
| De zorgverstrekker bepaalt op welk niveau de patiënt dient te oefenen. (1) | ○ | ○ | ○ | ○ | ○ |
| De patiënt bepaalt het niveau van de oefening. (2) | ○ | ○ | ○ | ○ | ○ |
| Het wearable systeem bepaalt aan de hand van artificiële intelligentie (=soort algoritme) op welk niveau de patiënt dient te oefenen. De zorgverstrekker kan dit niet corrigeren. (3) | ○ | ○ | ○ | ○ | ○ |
| Het wearable systeem gaat zelf aan de hand van artificiële intelligentie naar een volgende niveau. De zorgverstrekker kan dit niet corrigeren. (4) | ○ | ○ | ○ | ○ | ○ |
| Het wearable systeem bepaalt aan de hand van artificiële intelligentie op welk niveau de patiënt dient te oefenen, maar de zorgverstrekker kan dit corrigeren of het gebruik van AI uitschakelen. (5) | ○ | ○ | ○ | ○ | ○ |
| Het wearable systeem gaat zelf aan de hand van artificiële intelligentie (AI) naar een volgende niveau, maar de zorgverstrekker kan dit corrigeren of het gebruik van AI uitschakelen. (6) | ○ | ○ | ○ | ○ | ○ |

Q29 **d. Motivatie.**

In hoeverre bent u het eens met onderstaande?

1= volledig mee oneens
2= deels mee oneens
3= neutraal
4= deels mee eens
5= volledig mee eens

| | 1 (1) | 2 (2) | 3 (3) | 4 (4) | 5 (5) |
|---|---|---|---|---|---|
| De zorgverlener bepaalt op voorhand een baseline niveau voor de patiënt. (1) | ○ | ○ | ○ | ○ | ○ |
| Het wearable systeem bepaalt op voorhand een baseline niveau aan de hand van artificiële intelligentie voor de patiënt. De zorgverstrekker kan dit niet corrigeren of uitschakelen. (2) | ○ | ○ | ○ | ○ | ○ |
| Het wearable systeem bepaalt op voorhand een baseline niveau aan de hand van artificiële intelligentie voor de patiënt, de zorgverstrekker kan dit steeds corrigeren of het gebruik van AI uitschakelen. (3) | ○ | ○ | ○ | ○ | ○ |
| Het device maakt gebruik van in-app beloningen, bv het krijgen van punten. (4) | ○ | ○ | ○ | ○ | ○ |

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OPEN VRAGEN **8/9 - OPEN VRAGEN.**
Vul onderstaande open vragen zo kort en bondig mogelijk in.

Q30 **Gebruikt u reeds wearable technologie (sensoren, apps, …) in uw praktijk?**

○ Zo ja. Kan u ook ons vertellen welke, de reden, de doelen en wat de eventuele voordelen (meerwaarde) alsook nadelen zijn. (1) _____

○ Zo nee, wat zijn de huidige barrières die u tegenhouden om deze draagbare technologie op te nemen in uw praktijk? Barrières in zowel het gebruik van de sensoren alsook de smartphone/tablet applicaties. (2) _____

Q31 **Het gebruik van artificiële intelligentie in technologie zal de volgende jaren toenemen.**
Welke voordelen en/of nadelen ziet u aan het gebruik van artificiële intelligentie in de technologie voor gezondheidszorg.

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OPLEIDING **9/9 - OPLEIDING**

Q32 **Ervaart u een gebrek aan kennis omtrent het gebruik van technologie in de gezondheidszorg?**

- ○ Zo ja, motiveer: (1) _____
- ○ Nee (2)

Q33 **Is er vandaag voldoende aanbod in opleiding rond het gebruik van technologie in de gezondheidszorg.**

- ○ Ja (1)
- ○ Nee, motiveer: (2) _____

Q34 **Bent u bereid om een bijkomende opleiding te volgen rond het gebruik van technologie in de gezondheidszorg?**

- ○ Ja (1)
- ○ Neen (2)

Q35 **Over welke onderwerpen zou u graag een opleiding willen volgen?**
Meerdere antwoorden mogelijk.

- ☐ Wearables in de gezondheidszorg. (1)
- ☐ Virtual Reality (VR) in de gezondheidszorg. (2)
- ☐ Serious games in de gezondheidszorg. (3)
- ☐ Robotica in de gezondheidszorg met een focus op upper limbs. (4)
- ☐ Robotica in de gezondheidszorg met een focus op lower limbs. (5)
- ☐ mobile Health (mHealth) in de gezondheidszorg. (6)
- ☐ European Medicines Agency (EMA). (7)
- ☐ Remote monitoring en telerevalidatie. (8)
- ☐ Assistive technology. (9)
- ☐ Big Data in de gezondheidszorg. (10)
- ☐ Artificial Intelligence (AI) in de gezondheidszorg. (11)
- ☐ General Data Protection Regulation (GDPR) in de gezondheidszorg. (12)
- ☐ Product ontwerp voor de gezondheidszorg, incl. Medical Device Regulation (MDR). (13)
- ☐ Andere (vermeld de onderwerpen): (14) _____

Q36 **Als u nog iets met ons wil delen kan u dat hier doen.**

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