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Walk in Nature: exploring the potential of Virtual Reality as exercise therapy in the management of axial Spondyloartritis

A mixed methods approach

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Abstract

Background: Axial Spondyloarthritis (axSpA) is a chronic autoimmune disease that affects between 0.1 and 1.4% people globally and has profound impact on patients' quality of life. While guidelines emphasize the importance of physical exercise to alleviate symptoms and maintain mobility, studies report low adherence to exercise treatments within the axSpA population. Therefore, there is a need for innovative strategies that enhance these adherence rates. Virtual Reality (VR) as exercise therapy might be a solution to overcome the current challenges associated with low adherence.

Objective: To explore axSpA patients' attitudes regarding the use of VR, specifically the Walk in Nature program, as exercise therapy as well as its feasibility in the physiotherapy practice.

Methods: This study applied a mixed-methods approach and included axSpA patients and physiotherapists. A cross-sectional online survey was distributed between December 2023 and February 2024 via the MST hospital mailing list to 181 axSpA patients, of which 62 were completed. The survey was designed to capture patients' attitudes towards VR as exercise therapy using the constructs of the UTAUT model. In addition, the perceived usefulness of the Walk in Nature program's current functions and potential functions as recommended by the previous pilot study were explored. Furthermore, interviews were conducted with 10 physiotherapists to explore the program's feasibility in the physiotherapy practice using the NASSS framework. Lastly, the PSD model was used to capture physiotherapists' suggestions for optimizing the program with both stakeholders. The interviews were recorded, and the main themes were identified via general inductive coding.

Results: 62 axSpA patients completed the survey. Patients' attitudes were generally positive on all constructs of the UTAUT domains. The perceived usefulness was mixed on the current exercises and positive on three of the four potential functions. Additionally, while acceptability of the program was high among physiotherapists, they generally reported missing coaching and monitoring features. Moreover, usability was perceived as low. Physiotherapists mostly addressed concerns about the program's extensive equipment and complex start-up process. Lastly, while the physiotherapy practice was the primary setting of this study, both patients and physiotherapists reported preferring to use VR at home.

Conclusion: results indicate that the Walk in Nature program can be of added value as exercise therapy for axSpA patients. However, changes are necessary to further improve its fit with both end-users. The program's complexity should be lowered to facilitate use in the physiotherapy practice, while incorporating adjustable difficulty levels, coaching elements, and monitoring features may help to facilitate use at home.

Introduction

Axial Spondyloarthritis

Axial spondyloarthritis (axSpA) is a chronic disease characterized by inflammation and stiffness of the axial skeleton and sacroiliac (SI) joints [1]. AxSpA falls within a broader category of spondyloarthritis, a group of inflammatory rheumatic diseases that cause joint inflammation, pain, and stiffness. The global prevalence of axSpA varies between 0.1% and 1.4% [2], with symptoms typically manifesting between the ages of 18 and 35 [3]. While the exact cause is not known, genetic predispositions play a substantial role. For instance, 40% of axSpA patients have a positive family history [4]. In addition, a significant genetic marker is the presence of the HLA-B27 gene, which is found in 70 to 90% of individuals with axSpA [5]. Furthermore, immune activation by mechanical stress, such as physical forces, can lead to inflammatory responses through the production of pro-inflammatory cytokines [6, 7]. Gut dysbiosis is linked to the development of axSpA as well, and the gut microbiome of axSpA patients often displays an inflammatory profile [8]. Diagnosis of axSpA is based on an assessment of features indicative of the disease, including physical examinations, laboratory tests, and imaging [5]. Physical examinations typically assess the presence of symptoms or features associated with axSpA, while laboratory tests can identify HLA-B27 or inflammation markers [9]. Imaging modalities such as X-Rays are used to detect signs of structural damage in the axial skeleton and SI joints. The more recent inclusion of MRIs has enabled earlier diagnosis of axSpA patients, due to their ability to detect patients without visible damage on X-Rays [10].

One of the most common symptoms of axSpA is inflammatory back pain (IBP) [11]. Unlike typical back pain, IBP improves with activity but worsens during rest. Consequently, patients often suffer from nocturnal back pain and morning stiffness, especially in the lower back and hips. This leads to sleep disruptions and fatigue, which further exacerbate pain and stiffness [12]. Nearly 30% of axSpA patients also experience inflammation in peripheral joints, such as the knees or ankles [13]. Chronic inflammation in spinal tissues leads to new bone formation, which, in more progressive stages, causes the spinal bones to fuse together. This results in permanent postural changes [14]. Furthermore, inflammation sometimes extends to the rib-spine and sternum-rib joints, causing chest stiffness and breathing difficulties [15]. AxSpA is also associated with other conditions, such as psoriasis, uveitis, enthesitis and inflammatory bowel disease (IBD) [16, 17]. While axSpA has not been found to reduce life expectancy, it can increase the risk of life-threatening complications such as cardiovascular diseases, especially in advanced stages [18]. Next to physical limitations, patients also experience psychological distress. For instance, spinal deformations can lead to body image disturbances and are associated with lower mental wellbeing in axSpA patients [19]. Anxiety and depression are more common in the axSpA population compared to the general population, and frequent sleep disruptions have been found to contribute to this [20, 21]. AxSpA also limits participation in work and leisure activities. For instance, 45% of axSpA patients in a study by Cakar et al. [22] reported switching their jobs to less physically demanding ones due to the disease. The impact of axSpA on work productivity is a significant issue for patients, who see work capacity as a key element for quality of life [23]. Moreover, since axSpA starts early in life, work disability can lead to substantial economic consequences [24]. This calls for effective treatment strategies that slow disease progression.

Low adherence to physical activity

Since axSpA is incurable, treatment aims to slow disease progression and improve quality of life [25]. Besides pharmacotherapy, physical activity (PA) is highly recommended as therapeutic strategy. Studies demonstrated that PA improves spinal mobility, stiffness, pain, and pulmonary function in axSpA patients [26, 27]. Additionally, exercise programs have been shown to lower depression and improve pain, functionality and disease [28]. Following the European League Against Rheumatism (EULAR) guidelines, exercise programs should be performed regularly and focus on various domains such as cardiorespiratory fitness, muscle strength, and flexibility [29]. This diversity may contribute to overall health. In addition, exercises should be tailored to patient's fluctuating symptoms to lower the risk of injuries [30].

In The Netherlands, various exercise programs are available for axSpA patients, including supervised therapy, such as physiotherapy or group exercises, or unsupervised therapy, such as home-based exercises [31]. Research is inconclusive on which type of exercise program is most effective, and the choice might be best determined based on the patient's preferences [32]. Still, regardless of the setting, PA plays a crucial role in the management of axSpA. However, axSpA patients seem to struggle to meet PA recommendations in terms of frequency and intensity [33, 34]. Following literature, several factors may underlie the low adherence rates. First, competing demands from work, family, or social activities might distract patients from exercising regularly. For instance, studies found that axSpA patients often saw lack of time as a barrier to exercise [35]. Second, patients sometimes experience an increase in symptoms after exercising. As stated earlier, chronic stress on the joints can lead to an increase in symptoms. A review by Veldhuizen et al. found that pain and fatigue resulting from exercising were cited as reasons to stop exercising among axSpA patients [36]. Third, exercise may be perceived as too boring, lowering patients' motivation. Literature identifies motivation, particularly intrinsic motivation (IM), as key determinant of PA [37]. IM drives activity through intrinsic rewards (e.g. interest), rather than external rewards (e.g. a price), which is the case with extrinsic motivation (EM) [38]. IM increases when internal human needs, such as competence or autonomy, are satisfied. Among axSpA patients, exercises are sometimes reported as monotonous [39]. Thus, current exercise programs may not trigger patients' IM enough to keep doing it.

In conclusion, while guidelines clearly state the benefits of PA for axSpA patients, adhering to recommendations seems a challenge. However, axSpA is a lifelong disease and demands lifelong therapy to slow progression. Therefore, it is important to find strategies that target the barriers of current exercise programs. New methods that allow patients to practice at their time preferences and increase IM may be a first step to improve adherence rates.

Virtual Reality to optimize exercise behaviour

Virtual Reality (VR) might be a solution to the afore-mentioned challenges. VR is described as "an advanced form of human-computer interface that completely immerses users in a computer-generated environment" [40]. The original purpose of VR lay within the entertainment sector but later expanded its reach to other fields, among which the healthcare sector. The technology has already been applied in the treatment of some health diseases, such as neurological or mental conditions [41].

VR and its components may help increase PA levels as well. First, its immersive nature might facilitate higher engagement with exercises than traditional therapy. Immersion is described as "the extent to which a computer display is capable of delivering an inclusive, extensive, surrounding and vivid illusion of reality to the senses of a human participant" [42], and ranges from non-immersive to fully immersive. Non-immersive VR operates through a screen, whereas fully immersive VR submerges users into a 3D environment via a Head-Mounted Display (HMD) [43]. The latter particularly enhances visual and auditory input. This leads to a heightened sense of presence, the feeling of being "inside" the environment, which increases engagement [44]. Higher immersion also potentially increases continuous use of a technology [45]. Second, studies suggest that VR is effective in reducing feelings of pain. While the mechanisms behind this are unknown, one theory is that high immersion lowers one's awareness of pain [46]. Karhan et al. [47] examined the effectiveness of a VR-based exercise in axSpA patients and found the intervention to significantly increase quality of life as well as decrease pain scores. Third, VR systems are often highly interactive, which may increase enjoyment. In the context of VR, interactivity relates to users interacting with the VR environment [48]. High interactivity can increase enjoyment, and higher enjoyment can lead to higher PA levels [49]. Debska et al. found that highly interactive VR led to prolonged PA levels and higher enjoyment among healthy adults [50]. Lastly, VR systems can overcome the barrier of lack of time. Exercising at home allows patients to be active at a time they prefer. Since VR systems are becoming more commercially available for the general public [51], they may offer a flexible way to be active.

The potential of persuasive technology

To increase adherence rates towards exercise, it is important that patients change their behaviour. Persuasive elements may help to trigger this. The term 'persuasive' refers to intentional elements that aim to change users' attitudes or behaviours in the desired direction [52]. It does so without trying to mislead or forcefully compel them, fostering a voluntary change. Moreover, persuasive elements have the power to make the interaction between users and a technology more enjoyable, appealing to their IM [53]. Literature suggests that persuasive technologies are more likely to be adopted by their intended users [54], and there is a growing interest in exploring how these technologies can enhance PA. For instance, Aldenaini et al. [55] examined the relationship between persuasive technology, PA and sedentary behaviour. They found that technologies with persuasive features more effectively promote PA levels within users than those without the features. Geuens et al. [56] examined how apps can increase adherence towards exercise among chronic arthritis patients, and concluded that future apps should incorporate persuasive elements to achieve this. Although the use of persuasive elements within VR is not yet extensively researched, studies have previously examined VR-based exercise programs that included persuasive features [57].

Walk in Nature Program

The Walk in Nature program (WN) is a VR environment, originally created by University of Twente (UT) to enhance subjective vitality among students by including psychological cues and physical exercises [58]. The program consists of a forest environment complemented with bird calls (Figure 1). Users can perform three exercises: the breathing tree exercise, the butterfly exercise, and the yoga exercise.

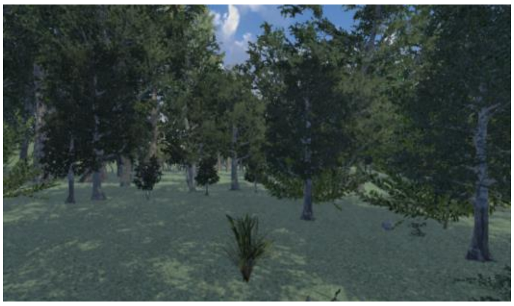


Figure 1*. The forest environment*

While the WN program was originally developed for other purposes, its components may help to improve exercise behaviour within axSpA patients. First, the program uses a HMD and produces natural sounds, which both contribute to greater engagement [59]. Second, the program contains interactive components, such as walking towards butterflies and touching them. This may increase enjoyment. Third, the exercises contain aspects that align with recommendations from the EULAR for axSpA patients. For instance, breathing exercises help to maintain pulmonary function, while stretching can preserve spinal mobility [60]. Additionally, studies found that tele-yoga can improve spinal mobility, and mental well-being in axSpA patients [61]. The exercises are also diverse, and this variety is recommended by the EULAR as well [62].

UTAUT to explore patient perspectives

Franke conducted a pilot study to assess the WN program's feasibility in the home and physiotherapy setting with axSpA patients and physiotherapists [63]. Initial findings were mixed, and more research is needed to determine the feasibility. Moreover, the topic of using VR as exercise therapy appears understudied in the literature. For instance, it is not yet clear whether this target group accepts VR on a larger scale. The Unified Theory of Acceptance and Use of Technology (UTAUT) model, as designed by Venkatesh, may contribute to new insights on this topic. UTAUT has successfully predicted technology acceptance in the past, and studies have shown that UTAUT can account for 70% of the variance in technology acceptance studies [64]. With the rise of technology in healthcare, UTAUT is increasingly applied towards health technology. For example, Nursch et al. [65] investigated patients' willingness to use digital consultations with UTAUT, while Tugiman et al. [66] explored patients' attitudes through UTAUT towards an electronic health record. However, its application towards VR in healthcare is sparce and mostly targets educational contexts [67]. This study is one of the first that uses UTAUT to identify axSpA patients' attitudes about using VR as exercise therapy.

NASSS to identify conditions for implementation

Both patients and physiotherapists in Franke's study generally preferred the physiotherapy practice for using the WN program [63]. Therefore, the potential of this setting should be further explored. The NASSS framework, short for Non-adoption, Abandonment, Scale-up, Spread, and Sustainability, is designed to understand the complexity of introducing health technologies into the healthcare setting [68]. NASSS helps to examine a technology's 'readiness' for integration into an organisation, which can predict its future success [69]. In addition, NASSS is designed for research in healthcare settings. The healthcare sector is perceived as a complex system, which can complicate the introduction of a new technology [70]. Consequently, introducing the WN program into the physiotherapy practice requires a thorough examination. NASSS has previously been used to assess the implementation of VR in the physiotherapy setting [71]. Thus, NASSS might provide new insights into the program's readiness and identify conditions for implementation of the program into the physiotherapy practice.

Aim of the study

This study aims to: 1) gain insight into how axSpA patients perceive the use of VR as exercise therapy on a larger scale, and to 2) examine the conditions for implementing the WN program into the physiotherapy practice. The study focuses on two primary end-users: physiotherapists and patients. To gain a deeper understanding of their individual needs, the research questions are divided for both stakeholder groups.

For patients:

- *What are axSpA patients' current exercise habits for coping with their symptoms?*
- *To what extent are axSpA patients willing to use the WN program as exercise therapy?*

For physiotherapists:

- *To what extent do physiotherapists find the current WN program feasible for use in the physiotherapy practice?*
- *What are physiotherapists' needs for facilitating implementation of the WN program in the physiotherapy practice?*
- *How can the WN program be further optimized to improve its fit with the primary end-users?*

Methods

Study overview
This study employed a mixed-methods approach. Both qualitative and quantitative research methods were used to gain deeper insight into the added value of the WN program from both patients' and physiotherapists' views. Figure 2 demonstrates how the mixed-methods approach was applied in this study. The goals of this study were two-fold: 1) to gain insight into patients' attitudes regarding using the WN program for exercising and 2) to identify needs of physiotherapists for implementing the program in the physiotherapy practice. For each aim, a different approach was used; therefore, the method section first focuses on patients and then on physiotherapists.

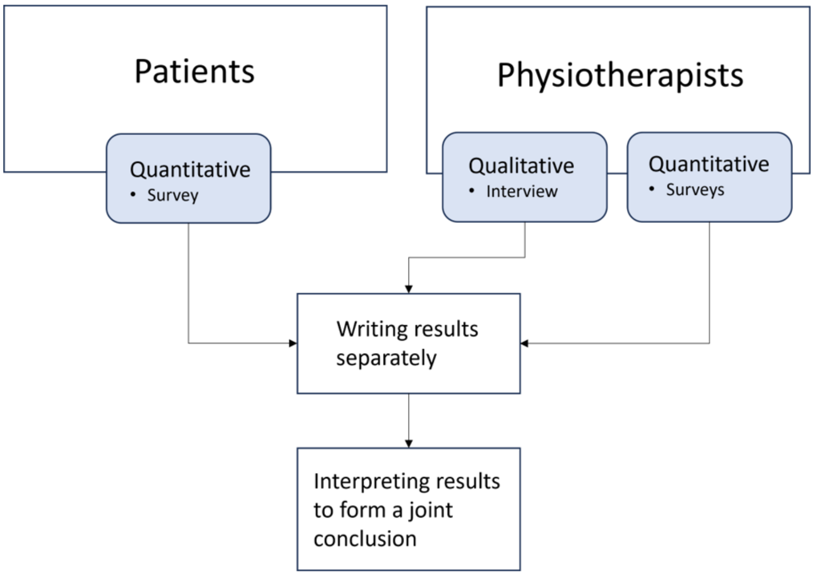


Figure 2. *Mixed-methods approach in this study*

Prior to conducting the research, ethical approval was needed from the UT's Behavioural, Management and Social sciences (BMS) lab as well as from the MST hospital. Therefore, a research proposal, including research objectives, methodology, and informed consent procedures, was submitted to, and approved by, the Board of Directors of the MST hospital (project number: K23-K25) and the Ethical Committee of the BMS lab from the UT (project number: 231453).

Methods section - patients

Participants and procedure
After performing a power analysis, the desired sample size for the patient survey was 383 with a 5% margin of error and 95% confidence level. Patients were approached via the mailing list of the MST hospital. The procedure took several steps. First, patients were selected based on the diagnosis treatment code lists from 2022 and 2023. Even though this would only include patients with relatively recent codes in the study, the researcher believed it would yield a diverse sample population, as the codes referred to diverse treatments.

In- and exclusion criteria
Patients had to be at least 18 years old, have a diagnosis of axSpA, have a registered e-mail address in HIX and have given consent to receive mails from the hospital.

Enrolment

Each patient was checked for 1) being an adult, 2) having a registered e-mail address in HIX (the hospital's health record), and 3) allowing the hospital to send information to the e-mail address. In total, the list included 252 patients. 60 patients were excluded following the exclusion criteria:

- Absence of a registered e-mail address in HIX (n=22)
- No registered consent from the patient in HIX to receive e-mails from the hospital (n=28)

The mail was sent to 202 patients. However, 21 e-mail addresses turned out invalid. Therefore, 181 patients received an e-mail with the survey link. The mail informed patients about the purpose of the research, the anonymity of the data, and the voluntariness of participation. The mail also included a unique study number to guarantee the patients' anonymity. Before starting the survey, patients were required to give consent and agree to the terms of the study. The survey required approximately 20 minutes to complete, and participants were able to participate only once. Patients were able to respond between December 28th, 2023, and February 1st, 2023. An example of the mail with the link can be found in *Appendix 2. .*

Measurements

The survey was created via a secured account on Qualtrics and can be found in *Appendix 3. Surveys*. The survey's main aim was to examine patients' attitudes towards using VR, specifically the WN program, with constructs of the UTAUT. Moreover, the researcher examined the perceived usefulness of the current functions and potential functions of the WN program as recommended by Franke [63], as well as location preference. The survey consisted of six parts:

1. Introduction to the study
2. Socio-demographic data
3. Exercise habits
4. Introduction to the WN program
5. PU of the exercises and potential functions
6. Statements following the UTAUT domains

Socio-demographic data

The first part consisted of three socio-demographic questions. Gender and level of education were measured via multiple choice, and age via an open-ended question. Year of diagnosis was measured via an open-ended question as well. Lastly, the survey included experience with VR via multiple choice to capture the patients' familiarity with the technology.

Adopter type

Following the Diffusion of Innovations (DOI) theory by Rogers, innovations spread through society at via different adopter types: innovators, early adopters, early majority, late majority, and laggards [72]. Different adopter types have different affinities with technologies [73]. Since axSpA patients are potential end-users of the program, it would be interesting to find out in which categories they fall as the different categories may require different strategies. Adopter type was measured through the five adopter types, and for each type, a statement was created based on its definition. These are shown in the survey in *Appendix 3. Surveys*. Patients were asked to choose the statement that fit them best.

Exercise habits and satisfaction

Patients' current exercise habits and satisfaction were measured through five questions. Four questions focused on patients' current exercise habits and aimed to identify whether patients exercised due to their symptoms, how often, on which location (multiple possible answers), and whether they visit a physiotherapist for their symptoms. The questions were based on the survey by Sundstrom, Ekergård, and Sundelin [35] to assess exercise habits among axSpA patients.

Satisfaction with exercise routines was also an outcome of interest. Patients were asked to rate their satisfaction on a scale with items rating from 0 (not satisfied at all) to 10 (extremely satisfied). Patients were also asked if they wished to exercise more often and could explain their answers.

Perceived usefulness

To capture patients' opinions about the current functions (the three exercises), perceived usefulness (PU) of the Technology Acceptance Model (TAM) was added. The PU is widely considered as a predictor of technology acceptance [74]. Moreover, this study further explores potential functions that followed Franke's recommendations [63]: adding feedback on exercises, adaptable difficulty levels, gaming elements and a help desk for advice or questions. Patients' PU were examined on these potential functions as well.

The exercises and functions were presented to patients via three scenarios. Scenarios are a common method within the development of user-centred health technologies [75]. The scenarios aimed to clarify the content of the WN program, since patients were not able to try the program and only form an opinion based on the survey. Each scenario consisted of a fictitious axSpA patient that performed one of the exercises of the program. The fictitious patients were based on the interviews with patients in Franke's pilot study [63]. The PU was measured through two questions in which patients stated which of the exercises and the potential functions they perceived as useful and which as not useful. Patients were able to choose multiple options and explain their answers in the open-ended question that followed.

Preference of location

Patients were asked for their preferred location to use VR for exercising: at home, the physiotherapy practice, or another location.

UTAUT domains

The five UTAUT domains were included to examine patients' attitudes. The adapted definitions of each domain can be found in *Appendix 4. Adapted definitions*. For each domain, several statements were constructed to capture that domain, based on similar research [76-78]. The response to each statement was rated on a 5-point Likert scale, ranging from 1 (very unlikely) to 5 (very likely). The design and translation of the statements were done together with a Dutch alumnus of the UT (MSc) to increase the reliability and validity of the statements. In total, 15 statements were created, which are represented in Table 1.

Table 1. *Domains and their corresponding statements*

Domain	Statements
Performance Expectancy (PE)	I think the VR program can make exercising more fun
	I think the VR program could help me exercise more often
	With the VR program, I'd be more inclined to exercise
	I think the VR program can help reduce complaints
Effort Expectancy (EE)	I expect it would be easy for me to learn to use the VR program

	I expect to become skilled at using the VR program quickly
	I expect it to be easy to use the VR program
Social Influence (SI)	I would try the VR program if my rheumatologist recommended them
	I would try the VR program if I knew other patients had positive experiences with them
	I would try the VR program if family or friends recommended them
Facilitating Conditions (FC)	I expect to need little technical assistance to use the VR program
	I expect to be able to use the VR program without much help from others
	I expect that enough help will be available for me to use the VR program s
Behavioural Intention (BI)	If I had access to the VR program now, I would want to try it out
	I would like to try exercising with the VR program in the future

Data collection

After developing the survey, it was first administered to three persons with Rheumatoid Arthritis. The main purpose was to assess the clarity, content, and length of the survey. The individuals were selected via networking and were not included in the final recruitment process. Based on their feedback, the survey was revised. Most adjustments related to the formulation of the questions as well as clarifying the scenarios.

Data handling

The data were first checked for respondents with missing values. These respondents were removed from the final data analysis. Second, variables were recoded into categorical variables when necessary to perform the required analysis. No answers of the statements needed to be recoded, as they were all positively phrased.

Data Analysis

The Statistical Package for Social Sciences (SPSS) version 28.0.1.0 was used for the data analysis. Descriptive statistics were used to analyse socio-demographic data and data on current exercise habits, such as median, mean, standard deviation, and frequency. Cronbach's alpha was used to further assess the reliability of the UTAUT domains. Following guidelines, alpha >0.8 = very good, 0.6-0.7 = acceptable, and <0.6 = poor [79]. Additionally, the mean scores of each domain were compared to the neutral (3.0 = neutral on a 5-point Likert scale) to indicate patients' attitudes via one-sample t-tests. The same was done with the statements to identify outliers.

Age, education, adopter type, and level of interest are suggested to influence technology acceptance [72, 80]. Therefore, group comparisons were made to assess differences in patients' attitudes. Distribution of the data was assessed with the Shapiro-Wilk test to determine which type of test to use. This revealed that the data were not shaped normally ($p < 0.05$). Therefore, the non-parametric Mann-Whitney U test was used to compare mean scores between groups. This involved several steps. First, the variables of interest were split into variables with two levels to create groups for comparison. Age was split into younger (18 to 55) and older (56 and older). Younger people may be more comfortable with using technology, which may influence their attitudes. Education level was split into lower education (no education, lower and higher secondary vocational education) and higher education (university of applied sciences, academic university). As higher educated people often have more access to technology compared to lower educated people, this may also influence their perception of and comfortability with technology [80]. Adopter type was split into early adopter (innovator, early adopter) and late adopter (early majority, late majority, laggards). Early majority was assigned to the late adopter group as they are often hesitant to purchase new technology. This is the opposite from the innovators and early adopter, who test or buy a technology before or right after it has come to the market [81]. Lastly, interest in VR was split into interested (interested in using the VR program) and uninterested (uninterested in using the VR program), based on the mean outcomes of the statements in the BI domain. Patients with a mean of 3.5 were counted as 'interested', as this can imply an interest in using a technology now or in the future [82].

Methods section - physiotherapists

Participants

Physiotherapists were recruited through purposive sampling by sending e-mails. The aim was to recruit physiotherapists with experience in 1) using VR in the physiotherapy practice, 2) implementing technology in the physiotherapy practice, or 3) treating axSpA patients. The purpose of this was multifold. First, it was expected that physiotherapists with VR experience could help examine the feasibility of the WN program in the physiotherapy practice. Second, physiotherapists experienced in technology implementation could identify challenges regarding the program's implementation into the physiotherapy practice. Third, physiotherapists with experience in treating axSpA patients have experience in working with the target group and could provide input on the current fit of the program with the target group. In addition, physiotherapists were required to be fluent in Dutch, be over 18 years old and be able to physically wear the VR headset. Physiotherapists were excluded if they were not BIG registered or had any visual, hearing, or cognitive impairments that would limit their ability to take part in the study or lead to safety risks, such as dizziness, balance disorders or claustrophobia. Based on similar research, the aim was include at least 10 physiotherapists to capture broad perspectives [83].

Procedure

Physiotherapists willing to participate could express their interest via mail or telephone, after which a 10-minute pre-screen call was planned via Teams to explain the study and check for eligibility. Of the 11 physiotherapists that underwent the pre-screen call, 10 enrolled within the study. 1 therapist was unable to participate due to scheduling difficulties.

Physiotherapists who enrolled in the study received a Participant Information Form (PIF) via e-mail, which provided details regarding the study's objectives and the interview procedure (*Appendix 2.).* In the same mail, the date and time for the interview was scheduled. One week prior to the interview, participants received an online survey with socio-demographic questions via email. Anonymity was ensured by assigning each participant to a unique study number.

Procedure on the day of the interview

The interviews were conducted at the UT in Enschede, The Netherlands, between the January 29th and February 12th, 2024. On the day of the interview, the physiotherapist (hereafter the participant) received a verbal introduction regarding the background and purpose of the research. The participant viewed and signed the informed consent.

VR procedure

First, the researcher demonstrated how to set-up the equipment and start the program on the laptop and the headset. This demonstration allowed participants to see which steps were needed to get the equipment ready for use. Second, the participant was asked to verbally rate their current symptoms on a scale of 0-20 as part of the Fast Motion Sickness Questionnaire (FMS) and briefed about the option to stop if discomfort would arise while wearing the headset. After explaining how to use the headset and controllers, the researcher assisted the participant in putting on the headset and then started the WN program, immersing the participant into the forest environment. The participant was allowed time to acclimate and, when reported ready, the researcher activated the exercises. The initial procedure included all three exercises. However, due to technical difficulties, the most current version of the program was lost, resulting in a former version in which the breathing tree did not work properly. Participants were still able to try the exercise but were also given verbal explanation of its intended purpose. Participants performed the butterfly and the yoga exercise. Within the butterfly (Figure 3), the participant finds himself inside a bush and must walk around to touch the butterflies that are spread out over the bush to make hem fly away. In the yoga exercise, the user takes part in a yoga class, accompanied by a yoga instructor and two fictitious co-participants (Figure 4). For each pose, the yoga instructor first gives a demonstration. Next, all participants (including the instructor, co-participants and the user) repeat the pose.

***Figure 3**. The butterflies inside the bush*

***Figure 4.** The yoga coach (left side) and co-participant (right)*

After completing the exercises, the researcher stopped the program, retrieved the headset and controllers, and once again asked the participant to verbally rate VR sickness symptoms on a scale of 0-20 for the FMS. Next, the participant filled in an online survey that comprised the Igroup Presence Questionnaire (IPQ) and System Usability Scale (SUS). The researcher was not present in the room during this, to ensure that participants were not feeling pressured or distracted and could concentrate solely on the questions. After finishing the survey, the interview was conducted.

Interview

First, the researcher shortly discussed the details of the interview, such as the background, estimated time, anonymization of data, audio recording for data analysis and the participants' option to terminate the interview. After the participant verbally agreed, the audio recorder was started, and the interview began. Upon completion of the interview, the participant was asked to for final comments, after which the audio recording stopped.

Materials

VR equipment

All equipment was provided by the BMS lab at the University of Twente after granting ethical approval. The VR equipment consisted of an Oculus Quest 2 headset equipped with two controllers. The headset was selected based on feedback from the previous pilot, in which the Oculus Rift S was used. Participants in the pilot study found the Rift S to be heavy and uncomfortable [63], leading to the decision to use the more lightweight and user-friendly Oculus Quest 2. Prior to the VR experience, a software developer of the BMS-lab of the UT implemented adaptations to the program using C# based on recommendations from the previous pilot [63].

Although it was also recommended to have the WN program run independently on the VR headset, this was not yet possible to achieve within the study's timeframe. Therefore, the Oculus Quest 2 headset was connected via a link cable (5 meters) to an Alienware m16 laptop with a 13th Gen Intel core™ i7-13700HX processor (2.10 GHz), a 64-bit operating system and 32 GB RAM. Figure 5 demonstrates the set-up. The WN program operated on Unity version 2021.3.8f1 on the Alienware laptop. Lastly, to be able to operate the program on the Oculus VR headset, it was necessary to download the Oculus App on the laptop and create a free account.

Figure 5. *The set-up: the Alienware laptop is connected to the Oculus Quest 2 with a link cable*

Room

Figure 6 demonstrates the space necessary to walk around while wearing the headset. The total space available for testing the program was 3.5 by 4 meters. This was mainly necessary for the butterfly exercise, in which participants were required to walk around to catch the butterflies.

Figure 6. *The space in which users tested the program*

Figure 7*. Participant testing the program*

Data collection

Quantitative data

Socio-demographic data

One week prior to the interviews, physiotherapists were required to complete a survey on socio-demographic data. The data captured information regarding age, gender, level of education, work function, work experience, current type of work setting, experience with the target group, experience with using VR within the physiotherapy practice, experience with implementing technology within the physiotherapy practice, and type of adopter. Except for age, all data were measured through multiple choice questions. The full survey is presented in *Appendix 3. Surveys*.

Acceptability and practicality
Key areas of focus within feasibility studies are acceptability and practicality [84]. An important determinant of acceptability is perceived satisfaction with an intervention, which focuses on positive and negative effects of an innovation. To determine this, the I-group Presence Questionnaire and Fast Motion Sickness Questionnaire were used. Moreover, usability tests can detect whether a product is efficient and easy to learn, which are key determinants of practicality [84]. The SUS was used to examine this, as SUS is a frequently applied survey for evaluating VR usability [85].

I-group Presence Questionnaire (IPQ)
The IPQ is a reliable tool to measure sense of presence in virtual surroundings [86]. Presence refers to the user's perception of physically being in that surrounding. Presence is closely related to immersion and both influence VR's perceived effects [87]. The IPQ is a validated survey consisting of 14 items. All items are measured on a 7-point Likert scale, ranging from 1 (fully disagree) to 7 (fully agree). For this study, the official Dutch version of the IPQ was used [88].

Fast Motion Sickness Questionnaire (FMS)
The FMS was selected to capture symptoms associated with VR sickness. This occurs when visual motion cues are inconsistent with the physical motion experienced by users [89], which may lead to symptoms such as nausea or dizziness. This can affect satisfaction. FMS is a single-item rating scale where users are asked to rate their symptoms on a scale of 0 (no sickness at all) to 20 (extreme sickness) [90]. Its major advantage over other scales is its quick administration time and its ability to compare values: FMS is always used before and after completing the VR experience, which is not the case with other surveys such as the SSQ [90]. This can provide clear evidence of any changes resulting from the VR experience. One drawback is that FMS does not assess which symptoms are experienced. Therefore, when participants experienced symptoms, they were asked to clarify this.

System Usability Scale (SUS)
The SUS is a widely recognized tool for assessing usability with systems and has been found suitable within various healthcare-related settings [91]. Although the SUS is mostly applied within health websites, previous studies have used the SUS to test VR usability [92]. Therefore, the SUS was used in this study as well to measure usability, specifically for use in the physiotherapy practice. SUS consists of 10 items which are ranked on a 5-point Likert scale, ranging from "strongly disagree" to "strongly agree". The Dutch adaptation of the SUS by Ensink et al. [93] was used to evaluate physiotherapists' views on the program's usability.

Qualitative data
Qualitative data were gathered through semi-structured interviews, pretested by two physiotherapists—one with three years' experience in rehabilitation, and one with seven years of working experience, including axSpA patients. They provided feedback on the content, clarity, and structure of the questions. After making small adjustments, the final interview scheme was ready and is presented in *Appendix 5. Interview scheme*.

Phase 1
Questions within phase 1 captured physiotherapists' perspectives on the 'readiness' of the WN program and their needs to use the program in the physiotherapy practice. For this, the NASSS framework was used. Due to its broad applicability, not all domains were seen as relevant to identify conditions for use in the physiotherapy setting. Therefore, this study incorporated domains 1, 2, 4, and 5, which focus mainly on the illness (axSpA), the technology (WN program), the adopter system (physiotherapists and patients), and the organisational setting (the physiotherapy practice). The domains, their definitions and their adapted definitions for this study are provided in *Appendix 4.*

Adapted definitions. Questions were created based on these domains. Though the physiotherapy practice was the main focus, the interview also addressed other settings to capture physiotherapists' perspectives on which they preferred.

Phase 2

Phase 2 examined how the program can be improved for future use among both physiotherapists and patients. The purpose was for physiotherapists to come up with ideas or functionalities to improve the fit with both stakeholder groups. For this, interview questions were based on the categories of the Persuasive Systems Design model by Oinass-Kukkonen and Haarjuma [52]. According to the model, persuasive technologies should aim to include features of each of the four categories of the PSD model as this can increase the chance of adherence [94]. The four categories as well as their features are provided in *Appendix 7. PSD model*. The PSD model has previously been used to analyse and optimize health technologies that encourage PA levels, for instance in a study by Matthews et al. [95]. In this study, the PSD model was used as foundation for the interview questions in phase 2 of the interview.

Data handling

Audio recordings of the interviews were conducted using a Zoom H4N Pro voice/sound recorder, provided by the BMS-lab of the UT. Recordings were processed through Amberscript Software, and checked for errors by the researcher. Personal data details such as names were left out of the transcription.

Data analysis

ATLAS.ti was used to analyse the interviews via a general inductive coding approach, and the coding schemes can be found in *Appendix 6. Coding schemes*. The surveys were analysed through SPSS version 28.0.1.0. Descriptive statistics were used to calculate the mean and standard deviation (SD), frequencies and percentages of socio-demographic data. For the IPQ, overall score was calculated as the mean of all 14 items per respondent. For the FMS, score before using the VR equipment were compared with the score after using the equipment for each respondent. For the SUS, individual item scores were transformed into an overall SUS score, ranging between 0 and 100. According to the SUS guidelines, a score between 0 and 50 is considered 'not acceptable,' a score from 51 to 67 is seen as having marginal usability, and a score between 68 and 100 is deemed 'acceptable' in terms of usability [91].

Results

Results section - patients

Survey characteristics

63 patients filled in the survey (response rate = 34.8%). Of the patients that did not participate, six sent a mail back saying they did not want to participate, with no interest in VR as reason. Seven patients clicked the option “I do not consent” within the survey. The completion rate of the respondents that filled in the survey was 98,4%. The average duration of completion was 16 minutes (SD = 14 minutes).

Patient demographics

Table 2 demonstrates the patient characteristics. The male-female ratio was evenly distributed, with 56% men (n=34). Age distribution was negatively skewed (skewness = -0.463) and ranged between

25 and 83 years old. Almost half of the patients reported having VR experience. Almost half of the participants (29/62) had higher professional education as background. More than three-quarters of respondents (83%) were categorized as early adopter and early majority.

***Table 2**. Patient characteristics*

Characteristics	N (%)
Gender	
Male	35 (56)
Female	27 (44)
Age in mean (SD) years	55.1 (15.7)
Educational level	
Primary school	1 (2)
VMBO (lower secondary education)	5 (8)
HAVO/VWO (higher secondary education)	5 (8)
MBO (secondary vocational education)	21 (34)
HBO/WO (higher professional education)	29 (46)
Other*	1 (2)
Diagnosis in mean years (SD)	24.11 (7.72)
*Experience with VR***	
Yes	26 (42)
No	36 (58)
Type of adopter	
Innovator	2 (3)
Early Adopter	26 (42)
Early Majority	21 (34)
Late Majority	9 (15)
Laggard	4 (6)

*Home economics school, **Virtual Reality

Exercise habits

92% (n=57) reported performing exercises because of axSpA-related symptoms. Among the five who reported not engaging in exercises, one cited medical issues as main reason. The other four did not comment. Most patients exercise one to two times a week (34%, n= 21), followed by less than once a week (26%, n= 16), three to five times a week (19%, n= 12), daily (13 %, n= 8) and never(8%, n= 5). Moreover, the majority (65%, n=40) also visits a physiotherapist for their symptoms. Patients were allowed to select more than one answer to the question “Where do you perform the exercises?”. Figure 8 presents a Venn diagram illustrating the distribution of responses. 32 patients reported exercising exclusively at one location, with the majority exercising at home (75%, n=24). Moreover, 20 patients reported exercising at two locations, with the combination *home* and *physiotherapy practice* reported most often (14 times). Patients that exercised at other locations mentioned the gym (n=9) or outdoors (n=4).

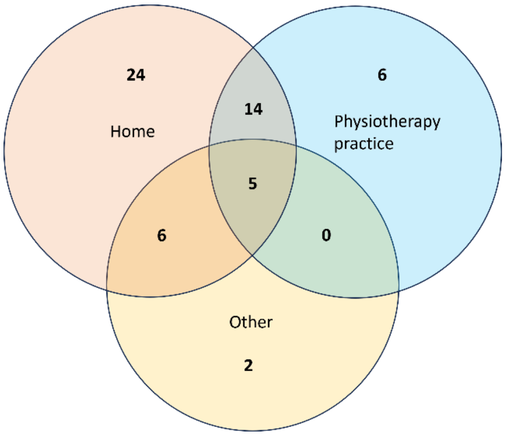


Figure 8. *Venn diagram of the different locations in which patients exercise*

Satisfaction with exercise frequency

The average satisfaction score was 5.7 (SD 2.2). Men, on average, rated satisfaction higher than women: 6.2 (SD 2.0) versus 5.3 (SD 2.3). Additionally, those who reported higher satisfaction scores (≥6) were on average slightly older (56.2 years) than those who reported lower satisfaction scores (≤4) (54.4 years). It was also observed that self-reported satisfied individuals mostly had HBO/University as educational level (66%), whereas self-reported unsatisfied individuals mostly had MBO as educational level (69%). Lastly, 60% (n=37) of respondents expressed a desire to exercise more frequently. This group also reported a substantially lower mean satisfaction score compared (4.9) to those without the desire to exercise more frequently (7.0).

Participants were invited to explain their satisfaction score. Among the patients that reported high satisfaction scores, general consensus was that they were able to find time to exercise: *"I can currently make time to exercise often enough." [165 – female, 52 years old].* Among self-reported unsatisfied individuals (score <=4), some patients reported not knowing how to do their exercises. Others mentioned how exercising sometimes increased their symptoms: *"I would like to [exercise] more often but at the same time this sometimes starts to hurt too much." [176 – female, 62 years old].* Lastly, some patients commented that they were unable to spend enough time exercising: *"I'm now dedicating too little time towards exercising." [136 – male, 59 years old].*

Results on PU and the location

Interest in using the program for exercising

65% (n=40) of patients were categorized as *interested in using the VR program*. The interested group was on average 54.7 years old with higher education (HBO/University) as the most common educational background. Patients categorized as *uninterested in using the VR program* were on average 56.2 years old, with lower education (MBO) as most common educational background.

Interested patients generally saw VR as a way to **disrupt boring routines**: *"I think VR can break tedious exercises." [75 – female, 48 years old].* Patients who were not interested in using VR generally did **not see its added value**: *"I can do these exercises on my own. I don't need VR goggles for that." [44 – female, 42 years old].* Others wondered whether the program would be **suitable** for their condition: *"I doubt whether the program is possible when you are bound to a wheelchair." [82 – male, 47 years old].* Others preferred the **social aspect** of exercising in the real world: *"I prefer to exercise in the real world with real people around me." [18 – male, 52 years old].*

Location for using VR to exercise
55% (n=34) were interested in using VR at home, whereas 37% (n=23) were interested in using the program at the physiotherapy setting. Respondents were also able to suggest other locations, however, no other locations were suggested. Regarding VR at home, patients largely valued the **flexibility** that VR offers at home since this was most frequently cited. For instance, most respondents anticipated that using VR at home would allow them to exercise at their preferred time: *"Then I can practice in my own time" [63 – female, 73 years old].* Others mentioned **comfortability** as reason: *"I feel more comfortable at home" [190 – male, 60 years old].*

Regarding the physiotherapy practice, a common reason was the preference for **physical guidance**: *"I prefer to do this under guidance at the physio" [24 – male, 44 years old].* Some participants believed that the physiotherapy practice might feel as more of a **commitment** compared to at home: *"Then there is more of an incentive to exercise." [138 – female, 41 years old].* Several participants also saw the physiotherapy practice as an **opportunity to practice** with the program before using it at home: *"I think I need some guidance first, then I can practice at home." [107 – male, 68 years old].*

Perceived usefulness of current exercises
Figure 9 presents the results of perceived usefulness (PU) of the WN program's exercises. The *butterfly* exercise was most often perceived as 'useful', and *yoga* exercise most often as 'not useful'. At the same time, patients were generally positive about the **stretching possibilities** in the *yoga* exercise: *"Stretching exercises like this yoga would be great for me" [67 – male, 69 years old]* – as well as the **demonstration by the coach**: *"To be able to exercise, it is convenient that they are demonstrated in advance." – [122, male, 64 years old].*

Regarding exercises seen as 'not useful', patients generally reported that some exercises were **not applicable** to them: *"I don't need breathing exercises. I only do exercises to remain my mobility."]165 – male, 69 years old].* Moreover, some mentioned that they already do **similar exercises**: *"I already do yoga" [31 –female, 24 years old]* – while others reported it was **not clear what the exercises entail**: *"I don't know how the breathing would work with VR." [71 – female, 69 years old].* In total, 6% (n=4) perceived none of the exercises as useful.

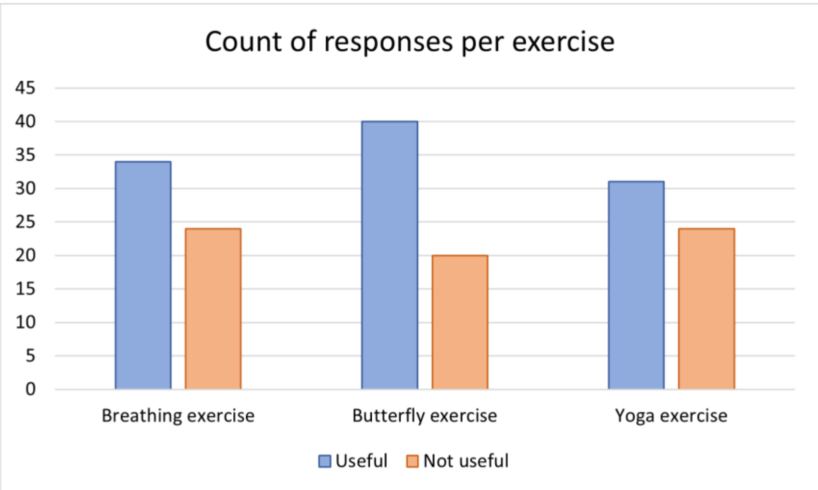


Figure 9. *Respondents' counts of perceived usefulness per exercise*

Perceived usefulness of potential functions
Figure 10 depicts the PU of potential functions. *Feedback on exercises* was most often seen as 'useful', while *help desk for answering questions* had the lowest counts. At the same time, *help desk*

was most often reported as 'not useful', while *adjustable difficulty levels* had the lowest counts. 3% (n=2) perceived none of the functions as useful.
Regarding functions seen as useful, most patients stated they want to know **whether they do exercises correctly** and felt that this was sometimes missing at home: *"If it can tell me how I should do my exercises then I'm all for it." [12 – female, 64 years old].* Some said that the adjustable difficulty levels may **help with changing symptoms**: *"Every day I need to check how bad my symptoms are. If this can help with that, I'm all for it." [164 – female, 56 years old].* Regarding functions seen as 'not useful', patients mostly reported reasons relating to VR in general instead of the functions. Regarding the helpdesk, several patients thought this **would not directly help them to exercise**: "*Maybe the helpdesk helps for questions, but I don't see direct value for exercising." [140 – male, 59 years old].*

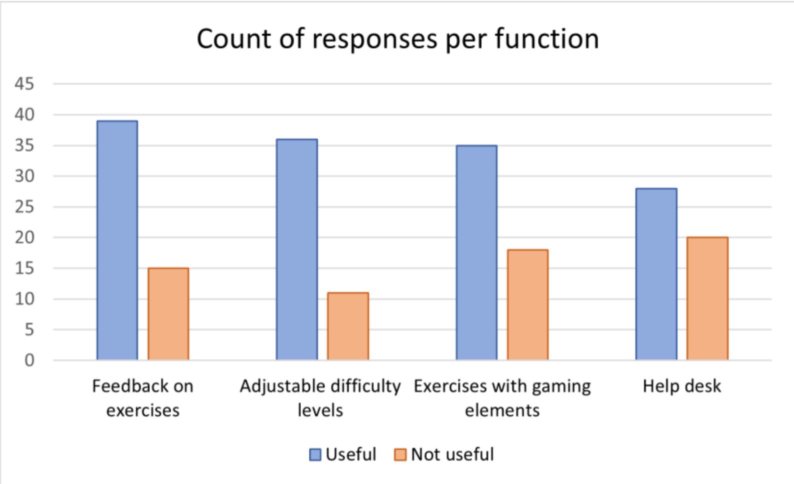


Figure 10. *Respondents' counts for each function*

Patients' attitudes using the UTAUT domains

To examine patients' attitudes, mean scores of each UTAUT domain were compared to the neutral score (3.0) with a one-sample t-test. Table 3 depicts results. Cronbach's alpha values exceeded the threshold of 0.8 for each domain. Moreover, for all five domains, the mean scores were significantly higher than the neutral score.

Table 3. *Mean score for each domain of the UTAUT model for all respondents grouped together*

Domains	**Number of items**	**Cronbach's Alpha**	**Mean (SD) [range 1-5]**
Performance Expectancy	4	0.901	3.60 (0.90)**
Effort Expectancy	3	0.869	3.83 (0.91)**
Social Influences	3	0.902	3.81 (0.98)**
Facilitating Conditions	3	0.842	3.81 (0.86)**
Behavioural Intentions	2	0.893	3.85 (1.09)**
***p<0.01.*			

Group comparisons

Table 4 displays the group comparisons, following results from the Mann-Whitney U test. No significant differences were found between age, educational level, and adopter types. Comparisons between people categorized as interested and uninterested demonstrated that, for all domains except Effort Expectancy and Facilitating Conditions, the interested group had significantly higher means compared to the uninterested group.

***Table 4**. Results of the Mann Whitney U test for group comparisons between domain means (SD)*

Factors	Subgroups	N	PE	EE	SI	FC	BI
Age	18-55	28	3.42 (0.78)	3.93 (0.77)	3.87 (0.89)	4.09 (0.77)	3.77 (1.14)
	56-85	34	3.75 (1.02)	3.75 (0.98)	3.76 (1.12)	3.58 (0.86)	3.92 (1.06)
Education	Higher education	29	3.62 (0.82)	3.93 (0.83)	3.81 (0.95)	3.86 (0.82)	4.14 (1.12)
	Lower education	33	3.58 (0.97)	3.74 (0.99)	3.81 (1.02)	3.77 (0.91)	3.25 (1.06)
Adopter type	Early adopter	28	3.78 (0.58)	3.71 (0.78)	3.89 (0.92)	4.04 (0.87)	4.14 (0.92)
	Late adopter	34	3.45 (0.98)	3.65 (0.95)	3.53 (1.03)	3.82 (0.88)	3.84 (1.08)
Interested in using the VR program	Yes	40	4.10 (0.61)	4.01 (0.73)	4.26 (0.62)	3.87 (0.69)	4.35 (0.70)
	No	22	2.69 (0.89)**	3.41 (1.00)	3.28 (1.04)*	3.71 (1.08)	3.24 (0.92)*
**p<0.05, **p<0.01. N = number of patients, PE = Performance Expectancy, EE = Effort Expectancy, SI = Social Influence, FC = Facilitating Conditions, BI = Behavioural Intentions*							

Given the substantial differences in attitudes between interested and uninterested patients, the researcher also compared their individual statements. The main purpose was to uncover outliers, which might indicate a facilitator or barrier towards using the program. Table 5 displays the results. The uninterested group displayed greater intragroup variability, showing a broader range of responses. Item SI1 demonstrated the highest mean score for both groups. Furthermore, within the uninterested group, item PE2, PE3, PE4, SI3, and BI1 were below neutrality.

***Table 5.** Group comparisons for all items between patients rated as 'interested in using VR' and patients rated as 'uninterested in using VR'*

Domains	Items	Interested in VR as exercise therapy	Not interested in VR as exercise therapy
PE	I think the VR program can make exercising more fun	4.37 (0.63)**	3.17 (0.79)
	I think the VR program could help me exercise more often	4.13 (0.84)**	2.43 (0.85)
	With the VR program, I'd be more inclined to exercise	4.18 (0.73)**	2.65 (0.73)
	I think the VR program can help reduce complaints	3.71 (0.73)*	2.91 (0.85)
EE	I expect it would be easy for me to learn to use the VR program	4.01 (0.83)	3.27 (1.15)
	I expect to become skilled at using the VR program quickly	4.00 (0.76)	3.48 (1.20)
	I expect it to be easy to use the VR program	4.05 (0.80)	3.43 (1.20)
SI	I would try the VR program if my rheumatologist recommended them	4.63 (0.55)*	3.82 (0.75)
	I would try the VR program if I knew other patients had positive experiences with them	4.35 (0.75)**	3.24 (0.94)
	I would try the VR program if family or friends recommended them	3.91 (0.86)**	2.68 (1.02)

FC	I expect to need little technical assistance to use the VR program	3.68 (0.97)	3.54 (1.34)
	I expect to be able to use the VR program without much help from others	3.95 (0.94)	3.78 (1.20)
	I expect that enough help will be available for me to use the VR program s	4.02 (0.66)	3.78 (0.85)
BI	If I had access to the VR program now, I would want to try it out	4.23 (1.04)**	2.99 (1.06)
	I would like to try exercising with the VR program in the future	4.51 (0.65)*	3.51 (0.97)
**p<0.05, **p<0.01. PE = Performance Expectancy, EE = Effort Expectancy, SI = Social Influence, FC = Facilitating Conditions, BI = Behavioural Intentions, VR = Virtual Reality*			

Results section - physiotherapists

Sample characteristics

Table 6 presents characteristics of the physiotherapists. Physiotherapists were relatively young with a mean age of 33.1 years (SD=8.7). Though all participants were qualified physiotherapists, one specified her function as 'physiotherapist with a master's in psychosomatic care'. 80% worked in a private physiotherapy clinic and most (n=5) had four to six years work experience. Furthermore, 50% (n=5) had experience with applying VR in their profession. Additionally, 70% (n=7) had experience with treating axSpA patients and 30% (n=3) with technology implementation. Lastly, most therapists categorized themselves as early adopter (n=9).

Table 6. *Physiotherapist characteristics*

Characteristics	**N(%)**
Gender	
Male	5 (50)
Female	5 (50)
Age in mean (SD)	*33.1 (8.7)*
Educational level	
HBO	9 (90)
WO	1 (10)
Profession	
Physiotherapist	9 (90)
Other*	1 (10)
Current work setting	
Private physiotherapy clinic	8 (80)
Hospital	1 (10)
Rehabilitation Centre	1 (10)
Work experience	
1-3	1 (10)
4-6	5 (50)
7-9	1 (10)
>10	3 (30)
Experience with VR in profession	
Yes	5 (50)
No	5 (50)
Experience with axSpA patients	
Yes	7 (70)
No	3 (30)
Experience with technology implementation	
Yes	3 (30)

No	7 (70)
Type of adopter	
Innovator	1 (10)
Early Adopter	9 (90)

* Physiotherapist with a master in psychosomatic care

Acceptability and practicality

Survey results

Table 7 demonstrates results of the surveys. Regarding the IPQ, overall mean (SD) was relatively high: 3.79 (0.87) out of 5. The FMS score demonstrated a slight increase in scores when comparing the 'before' scores with the 'after' scores for 50%(n=5) of the participants, with an increase with one or two points. Three physiotherapists stated that they experienced a slight headache, and two shortly felt slightly dizzy after using VR. SUS scores ranged from 57.5 to 75. A mean (SD) SUS score of 67.5 (5.39) (≥68 is considered acceptable [91]) was reported, with relatively high variability among therapists' total scores.

Table 7*. Quantitative results regarding acceptability*

Participant	Age	WE	VRE	axSpA-E	Mean IPQ	FMS before (after)	SUS scores
1	26	4-6	No	No	2.50	0 (0)	72.5
2	35	7-9	No	Yes	4.00	1 (2)	67.5
3	25	4-6	No	Yes	4.00	0 (2)	62.5
4	37	>10	Yes	No	2.50	0 (0)	67.5
5	25	1-3	No	Yes	4.75	0 (0)	75
6	29	4-6	Yes	Yes	4.00	0 (1)	67.5
7	42	>10	Yes	Yes	4.00	0 (0)	70
8	32	4-6	Yes	No	4.60	0 (0)	75
9	30	4-6	Yes	Yes	2.50	0 (2)	65
10	52	>10	No	Yes	5.00	0 (1)	57.5
Overall Mean (SD)					3.79 (0.87)	0.1 (0.30) before 0.7 (0.82) after	68.5 (5.39)

WE = Work experience, VRE = Virtual Reality experience, axSpA-E = axial Spondylartritis Experience, IPQ = Igroup Presence Questionnaire, FMS = Fast Motion Sickness Questionnaire, SUS = System Usability Scale

Qualitative results

Positive feedback about the program

All therapists were positive about the **headset**, generally perceiving it as comfortable: *"I really like the headset, it was very comfortable and easy to put on." [6 – male, 29 years old].*

Most therapists thought the program had **good visual aspects**. They were specifically positive about the submersion into the environment and the use of bird sounds: *"I like that I can completely look around here, and the bird sounds make me feel that I'm actually there" [5 – male, 25 years old].*

A reoccurring thought was the program's potential to **distract patients** from the pain: *"I think it's nice that you are completely surrounded, you know, that might distract patients from their pain and prompt them to go move just a bit further. I really like that." [4 – female, 37 years old].*

Moreover, several therapists believed that a VR-based program would **increase enjoyment with exercising** among patients: *"I think a VR program like this one definitely makes exercising more fun for patients." [3 – female, 25 years old]*. They thought this would increase patients' motivation. However, some feared that the program would not sufficiently lower patients' pain levels*: "I just wonder if it [the program] is enough to help lower pain levels." [9 – male, 30 years old].*

When asked about **VR-induced symptoms**, most therapists reporting experiencing no symptoms. While five therapists commented that they felt slightly dizzy or had a slight headache after use, all anticipated that this would not be a significant obstacle: *"I was a little dizzy, but I think that's because I've never used it before [VR]… And it would definitely not be an obstacle for me next time." [3 – female, 25 years old]*.

Several therapists also appreciated the **variety in exercises** and thought it well-suited for axSpA patients: *"It's nice that you've included all facets of exercises, so that it focusses on different aspects." [7 – female, 42 years old].*

Negative feedback about the program

Most therapists found the program to be **inefficient**. They generally perceived the current equipment as difficult to set up. Moreover, several made comments about the slow start-up process, stating this would take too long for use in the physiotherapy practice. Many anticipated that this would also be reflected among colleagues and patients, especially among those with higher age: *"It's not really a program of which you think 'grab and go'. I feel like… all the work you have to put in right now to use the program might just be too much for patients… This might be difficult for colleagues or patients, especially older ones" [9 – male, 30 years old].* Some therapists feared that this would reduce direct time with patients: *"In the private clinics you only have like, 30 minutes. A lot of client time goes wasted then on setting up this program" [6 – male, 29 years old].* While most physiotherapists thought the program had potential for the physiotherapy practice, they mainly preferred the home setting and related this the program's inefficiency for use within the physiotherapy practice.

Most therapists made comments about **exercises being static**. Most were related to their inability to track patients' movements: *"The exercises are very static. Like, with the yoga, I can just stand still, and the coach would not be aware of this and tell me if I did a good job" [10 – female, 52 years old].* Half made comments about the exercises having only one level. They thought that this would make the program less suitable for this patient group: *"What I like about giving therapy, is that you can so easily adjust your exercises based on what the patient tells you. If he has more pain, let's make the exercises easier, if not, let's try to take it further That is not really possible now." [9 – male, 30 years old]*

All therapists initially struggled with the **controllers**, and several specifically recalled this during the interview. However, most thought that this would go away after practicing: *"I did read which buttons to push in the instructions, but I just didn't know which button was where on the controller. But after the first exercise, everything went very easy. So, it's more about getting used where the buttons are and then I don't think it will be a difficulty anymore." [8 – female, 32 years old]*

Some therapists commented on the **high level of errors**, recalling errors they encountered during the try-out: *I just remember that, like, the yoga mat seemed to be floating." [10 – female, 52 years old].* Two therapists anticipated that these would lower their motivation: *"I feel like, the current errors are too high for me to work with the program. Like some of these errors, they just make it seem less real, and in this program, you want it to look real. So that would lower my motivation to use the program overall." [1 – male, 26 years old]*

Two therapists feared that the **weight of the headset** might be obtrusive for certain yoga poses: *"When I bent sideways, I felt the headset push in my face. That kind of got me out of the world, like, oh yeah, I'm doing exercises with a VR headset on, I'm not actually there. That was distracting." [4 – female, 37 years old]*

Conditions for use in the physiotherapy practice

In total, 4 themes were identified regarding needs for using the WN program in the physiotherapy practice.

Theme 1: Professional factors

The first theme focuses on factors related to physiotherapists' role as professional to guide patients with the program during physiotherapy sessions.

All physiotherapists highlighted the need of adequate **training to operate the program**. The general reason was to figure out practical considerations such as the time needed to set up the program during patient sessions. Moreover, several therapists feared that insufficient training could undermine professionalism: *"We had to set them [VR headsets] up during each session, and that didn't go very smoothly at the beginning. That doesn't seem professional." [7 – female, 42 years old]*

Eight participants commented on the time needed to **increase their own confidence**. Therapists felt this was necessary to learn operating the program, as they perceived the software as complex. Moreover, they generally wanted to feel confident enough before providing patients with adequate assistance: *"Ultimately, you do need the time. Because, you know, I also need to understand thoroughly what these exercises are about. Later, when the patient comes to me with questions, I need to know the answers." [5 – male, 25 years old]*

Several therapists mentioned needing sufficient time to **introduce the program to the patients**. They generally thought patients would need time and assistance to be able to use the program, especially older patients. Moreover, most therapists would like to "take it slow" to find out whether the program fits the patient's capabilities: *"Perhaps you could first assess how far you can go for each exercise together. So, practicing, "Okay, I can touch this many butterflies before going too far; this yoga pose helps, but this one causes too much pain..." This way, you also keep yourself safe." [3 – female, 25 years old]*

Some therapists reported that the **type of training** might influence how well they would learn to use the program and that types may differ among therapists. For example, some therapists stated how they would need physical training such as a workshop, while others thought online instructions such as videos or online meetings would be adequate. Other therapists suggested using colleagues as 'practice patients' to gain insight into the patient's perspective of using the program: *"And you can try it out yourself and with colleagues to see what exactly that experience is like. That also means that you can explain it better to the patient, so to speak." [1 – male, 26 years old]*

Four therapists mentioned the importance of having **personal technical support** in case technical problems arise. They believed this would help to maintain confidence, especially for therapists who are less secure in using technology. Participants suggested manual instructions, helpdesks, or an online website with FAQs where therapists can seek assistance. One therapist shared his experience with previous technical issues about VR *"If it [VR] doesn't work, then you feel like you've wasted half an hour of treatment for nothing. Colleagues are less enthusiastic to use it then, they skip it. You always need support for that." [4 – female, 37 years old]*

Lastly, two therapists with experience in VR shared how they often miss the option to **provide feedback about the system** to the development team. They both thought this would help to improve the program: *"With previous ones [VR], I sometimes wanted to report that some functions were just not useful, or I felt like something was missing. But often, there is no place to do that. So, I would like to see that back. It makes you feel heard too, that it's not just about developing and throwing it on the market and be like "good luck"." [9 – male, 30 years old]*

Theme 2: Organisational support

All physiotherapists stated the need for **an available room** in their practice where patients can use VR. While most did not see this as an issue within their own practice, suggesting using the private or general treatment room, many expressed concerns about this for other, mostly smaller practices: *"Yes, we have some space, but I can well imagine that three- or four-person practices have two treatment rooms and a coffee room. Then this is a lot less suitable" [6 – male, 29 years old].*

Additionally, some therapists worried about the suitability of the general exercise room, fearing that noise from others might be distracting. One therapist shared how their practice had created a special space for patients where they could use VR without distractions: *"But yes, I think it is very important that it [VR] can be done without distractions, so that is why we set up a room in the practice where they could do VR prior to the treatment. That really lowered the distractions for them." [9 – male, 30 years old]*

Many therapists raised questions about **the costs of purchasing the program**, stating it would be necessary to get insight into the costs of purchasing the program or the headset. Some therapists foresaw financial constraints and anticipated that practices would buy only one VR headset, while others thought one headset might be sufficient: "*However, when you buy one for the clinical setting, then I think more patients could use it, because therapists can share the headset and use it for all their patients combined." [4 – female, 37 years old].* However, consensus was that more insight would lead to better understanding of financial implications: *"If you have a clear overview of the costs, then you can think of, like, okay, how are we going to allocate our resources efficiently?" [8 – female, 32 years old]*

Seven therapists emphasized the importance of **support from staff**, such as colleagues and managers towards the program. They believed that this to be crucial to successfully integrate the program within the practice. Moreover, most thought that approval of colleagues and supervisors could motivate therapists and assist them in overcoming difficulties they may encounter: *"Yeah, I think that colleagues are very important in a way that VR can never reach on its own. It would be helpful if they back you up, let you know they believe in the project." [10 – female, 52 years old]*

Some physiotherapists believed there should be **a reservation system where therapists can see who reserved the equipmen**t. This mostly resulted from experience that multiple therapists sometimes want to use the headset at the same time: *"And our practice is quite large, if they all want to use glasses, I think you should have some kind of written or online system for when someone uses them. And for what reason." [6 – male, 29 years old]*

Lastly, some participants thought that **insight into the cost-effectiveness** might influence managers' willingness to invest in it. They suggested that if the program proves to be cost-effective compared to conventional treatments, practices may be more inclined to purchase it and that therapists may be more open towards using it. Many also believed this increased the chance of reimbursement from insurance companies, which could enhance accessibility for patients as well as for physiotherapists: *"Yes, the best for patients and therapists would be that it [program] is reimbursed by the health insurer. Then I think they might be more inclined to use it." [2 – male, 35 years old]*

Theme 3: Soft- and hardware considerations

All physiotherapists want more insight in the **required equipment** before using the program in the physiotherapy practice. For several therapists, it was not clear how the final version will look and which hardware they will need. Furthermore, two therapists mentioned the need for an extra desk chair, so that patients have the option to sit if some exercises are challenging for them: *"And if some patients cannot do yoga for that long, so these exercises are too difficult, then yes, you should also be able to sit on a chair. They can be done on a chair." [10 – female, 52 years old]*

Seven therapists expressed a need for **software compatibility support** when implementing the Walk in Nature program. They feared that the program might not be compatible with current software on their laptops. For example, two therapists with VR experience recalled how compatibility issues led to a less streamlined implementation: *"Yes, we also had such a program, but it didn't fit on the laptop because it was actually just too large, and we didn't have the right... well, the right software for it, and therefore we couldn't use it immediately." [3 – female, 25 years old]*

Several therapists stated that there should be clear agreements on who is responsible for **equipment maintenance**, such as periodic checking of all components: *"And you also should consider maintenance. So, who checks from time to time whether these wires still work? What if one is broken? Or what if the program needs updates? Who arranges this? Is it the therapists' responsibility? That should be talked about too." [5 – male, 25 years old]*

Some therapists wondered about **potential necessary subscriptions** to be able to use the headset or program: *"I know we had an Oculus once, and there we were forced to create subscriptions, and that cost money. Also, half of the time we forgot what the password was. It was just a bit of a nuisance." [9 – male, 30 years old]*

Two therapists wondered if **Internet connections would be needed** to use the program, and mainly related this to internet disruptions: *"I'm just thinking… what if the internet falls down? Will you still be able to use the program, or does it depend on Wi-Fi? That would make use more inconvenient." [2 – male, 35 years old]*

Lastly, when home use was on topic, two therapists commented on the **challenges of loaning equipment to patients,** speaking from their own experiences: "W*e no longer give the headsets to patients. No, because then another charging cord is lost... Is one broken, or did they do other things with it." [9 – male, 30 years old]*

Theme 4: Guidelines for effective use

A reocurring thought among seven therapists was the necessity for **clear protocol guidelines** that dictate when to use the program in the treatment process: *"It would be nice that you know a little about what guidelines you have for like, when to use the program. And how you can best integrate that, things like that. Then you also know what you are using the program for." [5 – male, 25 years old]*. Several physiotherapists thought that the program's usage should be flexible, initiated by either the physiotherapist or the patient whenever they feel it necessary. On the contrary, other therapists favoured a more structured approach: *"I would think that if you have a clear plan for such goggles, they [patients] will have more confidence in using them, especially if patients are not really familiar with them. And you may also achieve more consistent results than when you keep switching treatments." [6 – male, 29 years old]*

Physiotherapists also made several comments regarding the program not yet having a **demonstrated effectiveness.** When asked whether this was required to use the program in the physiotherapy practice, answers were divided. Some therapists agreed because they thought this improves patients' attitudes or increases physiotherapists' confidence to use it: *"It is beneficial for patients when the exercises are evidence based. Then they might be more open towards it. And for the physiotherapists as well, because I think that it [VR] will be used quicker then." [1 – male, 26 years old]*. However, many therapists also were open to try the program, even when not proven effective. For example, one therapist was interested in pilot testing the program's effectiveness in the physiotherapy practice. Others believed that the exercises were already built on a solid, evidence-based foundation: *"Most exercises are based on evidence-based exercises, like the breathing, and the stretching… Those are already important for this patient group. So, if the patient would be open to it, then I don't see a problem, even if it [the program] is not yet fully proven." [8 – female, 32 years old]*

Several physiotherapists would like more insight into which axSpA **symptoms the program can specifically target**: *"I still need to clearly define for myself what to focus on with a patient: is it the pain, or mobilization, or more breathing? Or can it be used to treat all symptoms at the same time? That I would like to know more about." [4 – female, 37 years old].* However, others thought this would not be a problem, stating that they would learn this when working with the program. Moreover, most therapists saw the program as a tool to encourage exercising. For them, usage would not depend on whether the program is applicable to the patients' symptoms: *"Well, I it is a* *great way to work on your movement either way, so even if not all exercises can be used for one patient, I might still recommend it just to make moving more fun." [7 – female, 42 years old]*

Theme 5: The need to increase usability for the physiotherapy practice

The main suggestion to improve usability was to **lower the necessary equipment**. Most therapists found the time to set up the equipment too long, and their general belief was that less equipment would increase usability and efficiency: *"I think, when you use just the VR goggles, it would be easier to set up and I would be more inclined to use it." [3 – female, 25 years old]*

Several physiotherapists stated that **removing errors** could increase overall trust in the program. They highlighted that the program should have as little errors as possible to increase its credibility: "*I would ensure that the program is free of errors and such because that tree wasn't working yet. Yeah, that does detract from the reliability." [2 – male, 35 years old]*

Moreover, several therapists prefer lowering the program's **start-up time**. For example, they described that the current program takes too long to start up due to the different apps and increases the risk of compatibility issues: *"You have like the Oculus app you need to check the equipment, the Unity app for the program, then in the Oculus environment the safety boundary you must draw… That is all a lot of software in which compatibility problems may arise." [9 – male, 30 years old]*

At the same time, the majority appreciated the **ability to "see what the patient sees**" on the laptop. For example, some therapists thought it helped them to monitor the patient's actions on the screen and provide specific instructions: *"I like how you can see what the patient is doing… You can really see where he's going, what he's doing, and give targeted instructions then." [8 – female, 32 years old].* Therapists generally preferred to keep this option for use within the physiotherapy practice.

Some therapists expressed concerns about the **safety of the cable**. For instance, tow therapists worried that patients might fall over the cable when being in the program: *"Patients could fall over the cable that is attached to the laptop" [7 – female, 42 years old].* However, most therapists did not think this would be a problem within the physiotherapy setting as they would be there to prevent this.

Three therapists would like to see the program used without **internet connections**: *"I know this might be difficult to achieve, but maybe, somehow, you can go around the whole… need for an internet connection. I've faced some serious problems with that in the past." [3 – female, 25 years old]*

Optimizing the program for use among end-users

Therapists were also asked how the program could be adjusted to increase its fit with the potential end-users. Following their suggestions, three themes emerged.

Theme 1: Increase self-sufficient use

All physiotherapists believed that the program needs adjustments to increase independent use among patients. First, all therapists struggled with the buttons and saw this as an obstacle for patients. To overcome this, several recommended **including a practice round** on how to use the buttons or within the exercises: *"When you wear the glasses you cannot see which button is where. So, patients need to know that. Maybe with some kind of exercise where they have to use the buttons." [2 – male, 35 years old].* However, others thought this was mainly the job of physiotherapists: *"Maybe first try it with us so that we can see that they do the exercise right, and then when patients are confident enough, they can use it on their own." [4 – female, 37 years old]*

Several thought the program should have a **clear navigation**, and proposed to include a menu with buttons where patients can click on exercises when arriving in the main forest. Three therapists suggested including simpler on/off buttons in to allow quick entering of the program. One therapist shared how previously, VR programs were sometimes divided into modules for guidance: *"Or we've also had modules in a previous VR headset, and each module meant a different task for patients to fulfil. But then they had more clarity on what was possible within the program. Maybe you can include this to within the program so that patients know what to expect." [9 – male, 30 years old]*

Half of the participants believed including **a tutorial might lower the barrier** for patients to use the program*: "Maybe you can give a tour through the program when patients first use it, so that they know what is possible within the program. That might help to lower the threshold to use it." [6 – male, 29 years old]*

Several participants were enthusiastic about the **inclusion of a helpdesk** for patients. They suggested that having access to technical support could increase patients' confidence and lower the program's threshold to use it: *"And I think that some sort of help desk might help patients to use the program quicker, you know, so when their questions are answered, they can continue using it." [4 – female, 37 years old]*

Lastly, some therapists suggested that patients should **only need the goggles** to use the program, so there is no need for a cable to connect the laptop. This was thought to lower complexity and safety risk: *"It might be a bit dangerous when you're walking around, trying to catch those butterflies… You don't know where the cable is." [6 – male, 29 years old].* The program should be used independently on the VR goggles according to them, without the need of external resources to activate the program.

Theme 2: Tailoring and monitoring

All therapists thought the program should be more **customizable to patients' abilities and preferences**. A general concern was that the exercises might be too difficult for some patients, while for others, the challenge might be too low: *"Having a difficulty level within the exercise itself could be a solution, also to change it to the patient's level." [5 – male, 25 years old].* When further exploring customizable levels, ideas generally related to the yoga and butterflies. Most suggested including easier or seated yoga exercises, and within the butterfly exercise, to include a calibrating feature where patients can adjust the height of the butterflies: *"If you can first try which butterflies you reach without pain, and which can't be reached, and then adjust their height on this, that might be more fitting." [4 – female, 37 years old].* Others proposed to include more customizable instructions, for example by making each instruction in text as well as audio: *"And they [patients] should choose how they want those instructions. So, text, or sometimes with a video." [3 – female, 25 years old]*

Physiotherapists also anticipated that **self-tracking features** would be useful. Most thought this would help patients understand the relationship between their exercise and their symptoms: *"When you see what the exercises can do to your symptoms, like, you see that exercising actually reduces your symptoms over time, you better understand what their relationship is." [6 – male, 29 years old]*. Most therapists want the program to measure symptoms including pain, stiffness, fatigue, or inflammation, while others also want to see where patients experience symptoms: *"Maybe you can include a picture of a body, and then patients have to point where it hurts." [9 – male, 30 years old]*

Physiotherapists also saw **challenges with self-tracking data**. The main concern related to axSpA patients having difficulty to manage their disease: *"They [axSpA patients] are not always that active in handling their disease, especially when there's not many symptoms yet." [2 – male, 35 years old].* Three therapists feared patients would be concerned with their privacy when tracking personal data and emphasized a need for personal accounts. Some also worried that self-tracking would lower motivation to use the program: *"I think you should question whether patients see it as added value. Suppose you have to fill in after each exercise, like, how is the pain, how is the fatigue, then that* *might lower the patient's enjoyment. Then he is reminded again that he is a patient." [1 – male, 26 years old].* To overcome this, they suggested to let patients decide which symptoms they want to monitor and how often.

When exploring this topic, several physiotherapists came up with the idea of a **dashboard** for home use. Consensus was that therapists often have little insight into patients' symptoms at home: "*I often don't see patients for months, until they come back with flare-ups. And many struggle to describe how they experienced their symptoms, in the past months, you know... They just remember it has gotten worse." [8 – female, 32 years old].* Others would mainly like insight into usage behaviour, such as when patients use the program, and which exercise they did most often: *"Maybe some kind of dashboard would be nice. Like, if you've discussed with the patients that we want to work on mobility, and indeed the patient has done exercises that involve a lot of movement, like the yoga, then yes, it does indicate whether the patient is motivated and taking steps themselves." [1 – male, 26 years old]*

Another suggestion was to include features that measure **quality of movement** during exercising. Therapists generally worried that within the current program patients might wrongfully execute some exercises: *"I find it very important that patients move correctly, especially with the yoga exercise as well. So, like, do you want to have a certain stretch somewhere? Then I think it's important that you stand properly and have good form, and not create more problems for yourself." [9 – male, 30 years old].* To overcome this, several recommended to include **sensors that capture the patients' movement**: *"Sensors could probably detect that breathing movement, and then you can attach a score to that breathing, like the quality of breathing." [2 – male, 35 years old].* One therapist was against sensors, because in her experience sensors were difficult to integrate: *"I don't like sensors and their technicalities, so maybe the patient can use their hands to feel breathing patterns on his stomach instead of sensors? Something like that is very low-cost."[4 – female, 37 years old]*

Theme 3: The importance of support

During the interviews, many physiotherapists emphasized the importance of providing motivation and support, and several ideas were related to this. All physiotherapists believed that including **gaming elements** would increase motivation and fun: "*I believe people might be more motivated when there are gaming elements, like points or an award. Then it is acknowledged that they did something, and that is a big motivator I've seen." [5 – male, 25 years old].* Within the butterfly and yoga exercises, it was often suggested to give a reward during and after the exercise: *"Something like a trophy or praising the patient, that might help to keep doing it [exercising]." [7 – female, 42 years old]*. However, some therapists were concerned that low scores could demotivate patients. Others reported that gaming elements should only be included if they align with the exercise goals: *"It also depends on what you want to achieve with an exercise. Like, do you want them to relax, or do you really want to capture that movement? Because in that last case, gamification might not be the most suitable option." [1 – male, 26 years old]*

Several therapists proposed to include more **coaching** in the system. They described coaching as a key element to encourage patients, especially when they have difficulties adhering to exercises: *"Patients sometimes tell me they have so many difficulties to do exercises on their own, but then at the practice, where they have our support and encouragement… I've been told that it makes a huge difference in terms of motivation." [10 – female, 52 years old]*

A few therapists supported the idea of including **social features** within the program, and mainly thought it increases fun. Two therapists proposed a multiplayer environment in which patients can practice the yoga exercise together. At the same time, they also acknowledged challenges such as programming complexity: *"I think it would be nice if you could do something* *together, for example exercise together like that yoga exercise. I think that is motivating. In some kind of multiplayer world, but I think that would be difficult to build in." [5 – male, 25 years old]*

Lastly, three therapists proposed to expand the program with **educational content**. They mostly related this to patients not knowing the importance of exercises: *"They [patients] often don't know how important exercising is, especially after being diagnosed. So, education on this might help them manage their condition."[6 – 29 years old]*

Discussion

While the program was originally designed to improve subjective vitality among students, findings suggest it might be of added value as exercise therapy for axSpA patients. Moreover, while acceptability of the WN program among physiotherapists was high, practicality was low. Changes are necessary to improve its fit with both axSpA patients and physiotherapists.

Main findings

High immersion might increase enjoyment and distract patients from their symptoms

According to both stakeholder groups, the program had several positives. Following physiotherapists' perspectives, the program has a high sense of presence and a low risk of VR-induced symptoms. While most physiotherapists thought the program could encourage axSpA patients to exercise, they believed VR would "not be for everybody". Indeed, results of the patient survey revealed that 35% of patients were categorized as uninterested in using VR to exercise. Interested patients generally saw the program as a way "to break tedious exercises" and were positive about its ability to increase fun with exercising. This was also reflected by most physiotherapists as well as the literature. For instance, a scoping review by Mouatt et al. [59] found that high immersive VR is better at increasing engagement and enjoyment with exercising than low immersive VR. Moreover, adding sensory features increases engagement, which was also found in a systematic review by Melo et al. [96]. The WN program's high immersion and use of bird sounds may add to greater engagement and enjoyment compared to current exercise routines.

Patients had generally positive expectations about the program's ability to decrease symptoms, while physiotherapists mainly thought the program could indirectly lower pain by causing distractions. Several experienced therapists with axSpA thought this to be particularly beneficial in axSpA patients with fear of movement. Kinesiophobia, fear of movement, is not uncommon in the axSpA population [97]. Some patients in this survey also reported being reluctant to exercise due to increased pain. Hoffman et al. [98] found that immersive VR is able to capture users' attention due to a high sense of presence. As the IPQ reflected a high sense of presence in the WN program, it therefore has potential to distract patients. However, literature shows inconclusive results about the success of VR to lower symptoms. Opara and Kozinc [99] demonstrated that immersive VR can improve kinesiophobia in people with chronic pain, but no effects were found on pain reduction. Mallary et al. [100] found that, while VR is effective for reducing acute pain, the results on chronic pain were inconclusive. Ioannou et al. [101] in their systematic review concluded that VR can be effective to manage acute pain in several patient populations, but that its effect on fatigue is understudied in the literature.

Thus, while it is unsure whether the WN program can decrease symptoms, its high immersion may facilitate engagement and enjoyment, which can potentially distract patients from their symptoms.

The program's perceived low usability may hinder integration into the physiotherapy practice

Physiotherapists generally thought that the current program would be difficult to use in the physiotherapy practice. For instance, they expressed concerns regarding the complex start-up process and difficulty of the controllers. The System Usability Scale (SUS) mean score was also slightly below acceptable levels. Contrarily, patients generally expected it would be easy to use the program, based on results from the Effort Expectancy domain. Their positive attitudes might be explained by the adopter types. Following the survey, most patients considered themselves early adopter or early majority. This indicates that they have affinity with technology and technological skills to some extent [72]. At the same time, while all physiotherapists considered themselves as innovator or early adopter, most found the program challenging to use. Patients may underestimate their technological skills when it comes to the VR program, especially since nearly half reported having no prior VR experience. Bally et al. [102] indicated that technologies perceived as too complex may lower users' perceived competence. More intuitive VR systems can increase feelings of competence and their willingness [103]. Thus, complexity should be lowered, and a first step could be to make the program autonomous for use, as recommended by most therapists. Further suggestions that were also used in other technologies were creating a menu with buttons for navigation [95], incorporating a tutorial into the program [55], and allowing users to rehearse using the controllers [54].

Older axSpA patients as potential target group

Physiotherapists mainly thought high age would lower interest or adoption among end-users. This was not reflected in the patient survey, in which no significant differences in attitudes were found between younger and older patients. However, literature states that high age is a common barrier for both healthcare providers (HCP) and patients to use VR [104]. At the same time, HCPs' beliefs on older patients' technological skills may hinder this group from using technology. Findings from a cross-sectional survey among 256 physiotherapists [105] demonstrated that therapists less frequently applied VR to older patients compared to younger patients. One therapist in this study mentioned how she often used "more traditional" methods for older patients that did not involve technology. Interestingly, only one patient in the survey used their age as a reason for not wanting to use VR. Moreover, mean age of the survey was relatively high, which can imply that older axSpA patients were interested in the program. This was also reflected in a study by Kiltz et al. [106], which found that older axSpA patients were more engaged with their app than younger patients. Studies have already shown that technology can be effective in older people [107], and the perception of older people being reluctant to use VR may be outdated [108]. For instance, a recent systematic review on older adults' perceptions of VR found their responses to be generally positive [109]. At the same time, the study acknowledged hard- and software adaptations might be necessary to fit VR systems with their capabilities. Thus, while high age can be a barrier towards technology acceptance, this study suggests that older axSpA patients may be interested in using the WN program. Therefore, this age group should be considered when further developing the program.

Look beyond the merely interested patients

The survey revealed that, compared to interested patients, uninterested patients were less positive about trying VR if they had access right now. However, both groups were generally positive about wanting to try VR in the future. This suggests that the uninterested group may be open to VR later, despite not being interested now. This indicates that their attitudes are not static but dynamic and might change over time. Following the Diffusion of Innovation Theory, this is possible: someone who is initially sceptical about innovations may develop an interest and decide to use a technology later on [110]. This was also echoed by two physiotherapists in this study, who mentioned that they only became enthusiastic about a certain technology after observing its benefits for others. Following Jamoom et al. [111], different perspectives, even among people with lower interest, should be considered when developing technologies so that the technology also takes their needs into account. In this study, there is potential for adoption beyond the merely interested patients, and future research should listen to needs of both interested and uninterested patients for using the program. Rheumatologists could play an important role in this, as both interested and uninterested patients had the most positive attitudes about trying the program if their rheumatologist recommended it.

Exercises are diverse but should be more adaptable to individual needs

Physiotherapists generally praised the program for its diverse exercises, believing this would suit broad patient needs. Results on the exercises' perceived usefulness (PU) in the patient survey may underscore this. The PU was mixed for all three exercises, indicating that not every exercise was seen as useful by each patient. Rheumatological guidelines suggest that axSpA patients should focus on exercises that are suitable to their capabilities [112]. In this way, the WN program's diversity in exercises might be a strength.

At the same time, physiotherapists emphasized the need for more adaptable exercises that fit with patients' abilities. Indeed, some patients in the survey wondered whether the program would be suitable for them as a wheelchair user, or as someone with comorbidities. Moreover, the 'adjustable difficulty level' function counted the second highest 'useful' score and the lowest 'not useful' score within the survey, further underscoring this need. Therapists proposed to add functions that allow customization, such as making the butterflies' height adjustable based on the patients' stretching abilities. This could ensure that the program is more tailored to the patients' need, which is also recommended by the EULAR guidelines [29].

Preferred location to use VR: home or physiotherapy practice

Both stakeholder groups prefer the program to be used either at home or in the physiotherapy practice. Physiotherapists generally envisioned long-term use of the program at home. However, they mostly related this to the program's low usability, finding it inefficient for use in the physiotherapy practice. Moreover, they prefer introducing the program to patients in their practice to see whether it suits patients, and to provide initial guidance. The latter was also reported by some patients who preferred the physiotherapy practice. For instance, one patient thought she would use the program at home after being instructed in the physiotherapy practice. Still, most patients preferred to home setting, relating this mainly to flexibility and comfortability.

Studies have previously examined VR-based exercise programs at home. Zernicke et al. [113] suggested that a VR exercise program at home can be beneficial for RA patients. A scoping review by Tokgöz et al. [114] concluded that while home-based VR exercises may be convenient, their use at home comes with challenges such as safety concerns and technical skills. A first introduction of the WN program in the physiotherapy practice, with supervision from a physiotherapist may help to introduce the program and ensure a safe transition to the patient's home.

The potential of sensors to evaluate patients' movements

Adding feedback on exercises was positively met by both stakeholder groups. Patients most often rated this function as 'useful', with some mentioning they want more feedback on their exercise performance at home. According to Dvorkin, Shahar, and Weiss [115], people often forget how to follow instructions at home, which can lower the exercises' efficacy. A focus group among physiotherapists on VR for musculoskeletal shoulder pain [116] revealed that therapists worried that VR causes injuries without proper guidance. Physiotherapists in this study feared the same for axSpA patients, who were described as "vulnerable" by several therapists. To overcome this, they suggested including sensors that track the patient's movements.

VR-based technology can already capture users' movements via sensors. For instance, accelerometers and motion capture technology can track limb movements [117], while algorithm-based sensors can measure breathing patterns [118]. These could be an option to measure the patient's movements within the WN program. At the same time, concerns about their high costs and complex development raises questions on their feasibility [119]. Additionally, studies often base their sensor's design on their own objectives and specific VR system. The WN program is a newly developed program with its own specific exercises, for which such sensors may not be applicable. Each exercise in the WN program also focuses on different types of movements. For instance, the breathing tree involves chest movements while yoga uses limb movements. This may require different types of sensors. In addition, to evaluate whether users exercise correctly, feedback must be linked to the captured data. Data must be translated to 'good' or 'bad' movements based on a set of criteria, and then provided to the user. This might be complex and poses a new challenge: what is considered a 'good' execution may differ greatly between axSpA patients, especially considering their differences in physical limitations.

Possibility of gaming elements

It is also important to define the primary goal of the WN program. It can be argued that the program should primarily attempt to increase intrinsic motivation (IM) and fun with exercising, given that these are main determinants of PA. In that case, it may be more viable to focus on adding gaming elements, since all physiotherapists thought that gaming elements could make exercising more fun. While patients rated 'gaming elements' frequently as 'not useful', they perceived the butterfly exercise as most useful. This may be due to the gaming element in the exercise. Studies have demonstrated the benefits of gaming on enjoyment and PA levels. Bandura concluded that interventions with gamification were more effective in promoting PA compared to interventions without gamification in different user populations [120]. However, at the same time, literature emphasizes that such elements should not be selected randomly as they carry adverse effects. For instance, studies have shown that offering rewards after finishing a task can undermine users' IM [121]. Rather, their selection should be based on well-researched theories. For example, their choice might be related to the three basic psychological needs as described by the Self-Determination Theory (SDT) [122]. Following this theory, to maintain and increase individuals' IM, it is required to fulfil three basic psychological needs: autonomy, competence, and relatedness. Autonomy is one's will to perform a task, competence is one's belief in the ability to complete a task and relatedness is one's need to connect with others. Satisfaction of the basic psychological needs can lead to greater enjoyment and IM, and a higher chance of adherence to the intervention [123].

Thus, besides focusing on sensors, studies could also explore the potential of adding gaming elements into the exercises. This might increase enjoyment, which can enhance IM. Sensors might still be useful, but it is uncertain whether their integration into the WN program is feasible.

Self-monitoring features may engage patients with their condition

For the future, physiotherapists suggested to add self-monitoring features to the program. The main reason was that this could help patients understand and manage their disease. Self-monitoring tools have been found to increase patients' self-efficacy [124]. Following the Social Cognitive Theory (SCT), self-efficacy within health-related behaviour is one's confidence to have control over health habits [125]. Higher self-efficacy results in higher commitment and facilitates behaviour change. Self-efficacy has been found to increase perceived competence as well as self-management skills [126].

In addition, physiotherapists generally want more insight into axSpA patients' symptoms between visits and felt that this is currently missing. One way to improve this, is by including self-rating scales that monitor symptoms such as pain, fatigue, and stiffness in the program. Such scales were also used in several apps to monitor disease activity in axSpA patients [127, 128]. Other ideas were for patients to mark areas of pain or stiffness on a picture of a human body in the VR environment, and to create a dashboard that visualizes the monitored data. In their study, Seppen et al. created several dashboards for Rheumatoid Arthritis (RA) patients that included symptom ratings and a human figure in which patients marked inflammatory joints [129]. Similar to their results, physiotherapists in this study agreed that a dashboard could show patients' symptom intensity, facilitate communication about their disease and help to create a more fitting treatment plan. For instance, one therapist thought that when patients regularly rate their symptoms while using the program, it might become clear to what extent exercising influence patients' symptoms.

While dashboards and symptom ratings are often used to monitor and present symptoms [130], their applicability in this context requires more research. Barnett and Sengupta in their pilot study found that RA patients stopped using their app because the monitoring tools were too long [131]. Therapists in this study warned for similar results if the program included too lengthy scales. In addition, the optimal frequency of monitoring is unknown. Some therapists thought patients should rate their symptoms every time they use the program, while others believed periodic ratings, such as once every two weeks, would be sufficient. Moreover, the use of self-monitoring tools might not be appreciated by every patient, depending on their preferences. Creating an option that allows patients to choose might help, however, this should be further examined. It is also not clear how feasible the creation of a dashboard in VR is. While literature is broad about the inclusion of self-monitoring tools into apps, its integration within VR systems is limited. Lastly, patients' perspectives on this topic have not been included and must be investigated before taking further steps. Nonetheless, there is an increasing interest in remote monitoring tools among the axSpA population [132], underscoring their potential for the WN program.

Adjustments are needed to use the program in the physiotherapy practice
The WN program does not yet seem ready for use in the physiotherapy practice. Besides usability, general concerns were low availability of rooms in small practices, and the expected high costs. These were mainly based on therapists' experiences with previous VR systems and are also reflected in literature, for instance in a cross-sectional survey among physiotherapists regarding their use of VR [105]. Therapists also discussed the importance of receiving enough training and support for familiarizing themselves with the program. They need time and resources to learn operating the program and to introduce it to patients. Moreover, therapists need technical support in case of questions or software disruptions. This should not be overlooked, as studies state how inadequate technical support can significantly lower adherence to technology [133]. Therapists would also like more clearance about the program's integration into axSpA treatment protocols and indications for using the program on axSpA patients. Additionally, a demonstrated effectiveness of the program was believed to support adoption. This also highlights a challenge: therapists prefer evidence of the program's effectiveness, but this is often examined via larger scales RCT's within real-world settings [134]. However, findings of this study suggest that first, hard- and software changes should be made to increase the program's fit with the primary stakeholders before focussing on the potential effectiveness. Van Gemert-Peijnen et al. designed the CeHRes roadmap, a framework to improve the uptake of eHealth technologies [135]. This roadmap emphasizes that each development phase should be followed by evaluation with primary stakeholders. Therefore, future studies should continuously involve physiotherapists after adjusting the technology to ensure a good fit.

Strengths and Limitations

Strengths
A strength of this study is that it applied a mixed-methods approach. This allowed the researcher to gain deeper insights into the potential of VR, specifically the WN program, as exercise therapy for the axSpA population. This study also used a holistic approach by involving both stakeholder groups. A holistic approach is crucial in the early design phase of eHealth technologies because this increases the likelihood of successful adoption and implementation in the future [135]. Involving the primary stakeholders helped to investigate the program's potential from their perspectives and identify points of improvement for the future. The study also operated based on multiple well-researched frameworks. The constructs of the UTAUT helped to capture axSpA patients' general attitudes about using VR as exercise therapy, while the NASSS identified requirements for implementing the program in the physiotherapy practice. Moreover, the PSD model assisted in gathering ideas on how the fit

between the WN program and both stakeholder groups can be further optimized. For instance, main suggestions generally related to the Primary Task Support and Dialogue Support categories from the PSD model. Such findings may inform future strategies that further refine the WN program. Lastly, testing the interview scheme and survey with individuals that fit the stakeholder groups ensured that both methodologies could be adjusted and strengthened before they were implemented. The high Cronbach's alpha score also indicated high internal consistency and high reliability of the UTAUT domains in the survey.

Limitations

The main limitation of this study was that axSpA patients were not able to express their thoughts via qualitative methods. While patients were able to explain their answers in the survey, methods such as interviews could have enriched this information. Additionally, the recruitment process was lengthier than anticipated and considering the study's timeframe, it was decided to stop recruiting after reaching 181 patients. Consequently, the survey did not achieve the desired sample size. Therefore, the results of this study have low statistical power and should be interpreted with caution. Also, the proportion of younger patients in the survey was small compared to that of older patients in the survey, and their opinions might have been underrepresented.

Moreover, the chosen theoretical frameworks may not have been adequate for the objectives of this study. First, the NASSS is a complex framework, consisting of several domains and subdomains. Given that only four out of seven domains of NASSS were used, the framework may have been too broad and not fit with the exploratory nature of this study. Second, during the interviews, physiotherapists were first asked to provide their own suggestions on how the program can be improved. However, follow-up questions were based on the four categories of the PSD model. This may have guided their ideas towards these specific categories, possibly missing ideas outside of the categories. Third, the UTAUT was used to determine technology acceptance. While it yielded a first insight into patients' attitudes, the inclusion of other constructs, such as those from UTAUT2, might have been more valuable. For instance, UTAUT2 also considers price/value, which focuses on the trade-off between the perceived benefits and the monetary costs of using a technology [136]. Costs may outweigh other constructs, such as perceived benefits, and thus more heavily influence people's attitudes [137]. Lastly, as the program is still under development, the software was continuously adapted and subject to change. Consequently, an earlier version of the game was used in this study instead of the updated version in Franke's pilot study [63], which was not optimized. This may have led to lower user experiences and influenced physiotherapists' perspectives about the program.

Future research

Initially, the WN program was developed to improve subjective vitality among students. Findings from this study suggest that the program has potential as part of exercise therapy for axSpA patients. However, the fit with this target group is not yet optimal. To improve this, research should further explore the inclusion of adaptable difficulty levels, lowering complexity, including gaming elements, and adding self-monitoring.

Currently, it is not yet clear whether adaptable difficulty levels are possible within each exercise, and what their design should entail. A first step could be to explore which mechanism should underlie this adaptability. For instance, literature states that difficulty levels in games are often adaptable based on system-controlled mechanisms or user-controlled mechanisms. Within system-controlled mechanisms, the difficulty level is based on real-time feedback [138]. Users' movements are monitored with sensors to identify their limits, and the exercises' difficulty level is adjusted accordingly. Within user-controlled mechanisms, users can manually adjust the exercise to their preferences, for instance by choosing the difficulty level themselves. It is important to determine which approach is most suitable for the program in the early development phase, as this can lay a foundation for future design of the difficulty levels. Orji, Oyibo and Tondello [139] compared the mechanisms in their review and found that, while both have strengths and weaknesses, users generally prefer system- over user-controlled adaptation. However, the use of system-controlled mechanisms such as sensors might be challenging, as discussed earlier. Future studies could therefore further explore this topic to determine which mechanism is the most feasible choice.

Since the Oculus Quest 2 was generally rated as comfortable in this study, it is recommended to continue using this equipment in future versions of the WN program. However, the cable might lead to patients feeling worried about tripping, potentially increasing complexity and lowering the immersive experience. Future studies should explore a cable-free or autonomous setup. Also, to further lower the program's complexity, attention should be given to features from the Primary Task Support category of the PSD model, such as including a menu, tutorial, or practice rounds to become familiar with the hand-controllers. In addition, while the inclusion of gaming features such as rewards might increase fun and motivation, their choice requires a deeper analysis. For instance, satisfaction of the basic psychological needs from the SDT can lead to higher IM. Future studies could use SDT as theoretical foundation to examine which gaming features have previously led to satisfaction of the basic psychological needs.

Future research could also examine the inclusion of self-monitoring features. Self-monitoring is both a persuasive design feature and a critical behaviour change technique to increase PA [140]. Interventions that included self-monitoring have been found more effective in promoting PA compared to interventions without self-monitoring [141]. However, within the context of the WN program, it is currently unclear what should be self-monitored when patients use the program, and how frequently this should occur. Also, patients' opinions on this topic were not explored in this study, and it may be that patients prefer other self-monitoring features or no self-monitoring features at all. In addition, it may be challenging to design functions that collect, store, and present the data to users in a VR dashboard. Future studies should therefore further explore this topic.

Future research should further investigate the topic of costs. For instance, while the UTAUT helped to capture axSpA patients' attitudes about VR as exercise therapy, none of its constructs focused on costs. At the same time, costs were mentioned as barrier towards adoption by most therapists in this study. Research also suggests that costs significantly influence people's technology acceptance [137]. Future research could further explore this topic by asking patients what they are willing to pay for the program, or by adding the price/value construct from UTAUT2 in future surveys. These insights could potentially inform future research focused on pricing strategies.

The feasibility of the physiotherapy practice should be further explored, for instance by also considering the wider organisational context. Following the Consolidated Framework for Implementation Research (CFIR), external factors beyond the organisation, or the "outer setting", such as external policies or financial regulations, can significantly influence a technology's implementation into an organisation [142]. Exploring the outer setting and its stakeholders, such as healthcare insurers, was beyond the scope of this study but should be considered in future studies. It is advised that further research continues with frameworks such as the CFIR to also explore these settings, instead of the NASSS. The CFIR is less complex in its application than the NASSS while still able to provide a detailed examination on this topic. Therefore, CFIR might be more suitable for the WN program's current phase. The NASSS might still be relevant in later stages, for instance to evaluate the program's sustainability after implementation. Lastly, another step could be to pilot test the WN program in the physiotherapy practice with both axSpA patients and physiotherapists. For instance, physiotherapists could guide patients with the program in their practice, followed by feedback from both stakeholder groups. This might provide additional insights due to a more real-world setting. This study design also allows for exploring the dynamics between the therapist and the patient that is engaged with the VR program. For instance, it is not yet clear whether using the WN program during sessions affects the communication between the physiotherapist and the patient.

Conclusion

This study explored the added value of the Walk in Nature program as exercise therapy for patients with axSpA, as well as conditions for implementation into the physiotherapy practice. Findings indicate a general positive perception towards using the program for exercising among both stakeholder groups. Patients had general positive attitudes regarding the UTAUT domains, and positively evaluated the perceived usefulness of adjustable difficulty levels, feedback on exercises and gaming elements. The low perceived VR-induced symptoms and high sense of presence among physiotherapists indicate a general acceptability of the program. Moreover, the program's high immersion may help to increase engagement and enjoyment with exercising, as well as distract patients from their symptoms. This could potentially increase their PA levels. At the same time, the results show that VR as exercise therapy is not meant for everyone. Older patients are seen as potential target group; however, future studies should further explore this to draw definitive conclusions.

This study also suggests to further enhance the program's fit with end-users before testing the program in the real-world setting. The low usability, high complexity and perceived low dynamic exercises add to this. The customizability of the exercises is seen as priority. Additionally, features from the Primary Task Support category of the PSD model could increase the user interface (a menu with buttons, a tutorial, practice rounds). Features from the Dialogue Support category could increase the user experience (adding rewards, praise, and feedback). However, their optimal content, timing and frequency should be carefully examined before incorporating them in the program. Especially the potential of providing feedback with sensors necessitates further research. Additional studies may also explore the potential of adding self-monitoring features, as physiotherapists placed high value on this for use at home. Lastly, since physiotherapists have limited time during patient sessions, the slow start-up process and extensive need of materials were seen as main barriers for implementation into the physiotherapy practice. These can be starting points to increase the program's suitability within this setting.

References

1. Poddubnyy D. Axial spondyloarthritis: is there a treatment of choice? Therapeutic Advances in Musculoskeletal Disease. 2013;5(1):45-54. doi: 10.1177/1759720x12468658.
2. López-Medina C, Moltó A. Update on the epidemiology, risk factors, and disease outcomes of axial spondyloarthritis. Best Practice & Research Clinical Rheumatology. 2018;32(2):241-53. doi: 10.1016/j.berh.2018.10.006.
3. Boel A, López-Medina C, Van Der Heijde DMFM, Van Gaalen FA. Age at onset in axial spondyloarthritis around the world: data from the Assessment in SpondyloArthritis international Society Peripheral Involvement in Spondyloarthritis study. Rheumatology. 2022;61(4):1468-75. doi: 10.1093/rheumatology/keab544.
4. Ez-Zaitouni Z, Hilkens A, Gossec L, Berg IJ, Landewé R, Ramonda R, et al. Is the current ASAS expert definition of a positive family history useful in identifying axial spondyloarthritis? Results from the SPACE and DESIR cohorts. Arthritis Research & Therapy. 2017;19(1). doi: 10.1186/s13075-017-1335-8.
5. Walsh JA, Magrey M. Clinical Manifestations and Diagnosis of Axial Spondyloarthritis. JCR: Journal of Clinical Rheumatology. 2021;27(8):e547-e60. doi: 10.1097/rhu.0000000000001575.
6. Van De Sande MGH, Elewaut D. Pathophysiology and immunolgical basis of axial spondyloarthritis. Best Practice & Research Clinical Rheumatology. 2023;37(3):101897. doi: 10.1016/j.berh.2023.101897.
7. Perrotta FM, Lories R, Lubrano E. To move or not to move: the paradoxical effect of physical exercise in axial spondyloarthritis. RMD Open. 2021;7(1):e001480. doi: 10.1136/rmdopen-2020-001480.
8. Cardoneanu A, Cozma S, Rezus C, Petrariu F, Burlui A, Rezus E. Characteristics of the intestinal microbiome in ankylosing spondylitis. Experimental and Therapeutic Medicine. 2021;22(1). doi: 10.3892/etm.2021.10108.
9. Diaconu AD, Ceasovschih A, Șorodoc V, Pomîrleanu C, Lionte C, Șorodoc L, Ancuța C. Practical Significance of Biomarkers in Axial Spondyloarthritis: Updates on Diagnosis, Disease Activity, and Prognosis. Int J Mol Sci. 2022;23(19). doi: 10.3390/ijms231911561.
10. Khmelinskii N, Regel A, Baraliakos X. The Role of Imaging in Diagnosing Axial Spondyloarthritis. Front Med (Lausanne). 2018;5:106. doi: 10.3389/fmed.2018.00106.
11. Lassiter W, Allam AE. Inflammatory Back Pain. United States: StatPearls Publishing; 2024.
12. Missaoui B, Revel M. Fatigue in ankylosing spondylitis. Ann Readapt Med Phys. 2006;49(6):305-8, 89-91. doi: 10.1016/j.annrmp.2006.03.007.
13. Martey C, Sengupta R. Physical therapy in axial spondyloarthritis: guidelines, evidence and clinical practice. Curr Opin Rheumatol. 2020;32(4):365-70. doi: 10.1097/bor.0000000000000714.
14. Robinson PC, Sengupta R, Siebert S. Non-Radiographic Axial Spondyloarthritis (nr-axSpA): Advances in Classification, Imaging and Therapy. Rheumatology and Therapy. 2019;6(2):165-77. doi: 10.1007/s40744-019-0146-6.
15. Kanathur N, Lee-Chiong T. Pulmonary manifestations of ankylosing spondylitis. Clin Chest Med. 2010;31(3):547-54. doi: 10.1016/j.ccm.2010.05.002.
16. Fragoulis GE, Liava C, Daoussis D, Akriviadis E, Garyfallos A, Dimitroulas T. Inflammatory bowel diseases and spondyloarthropathies: From pathogenesis to treatment. World J Gastroenterol. 2019;25(18):2162-76. doi: 10.3748/wjg.v25.i18.2162.
17. Ritchlin C, Adamopoulos IE. Axial spondyloarthritis: new advances in diagnosis and management. Bmj. 2021;372:m4447. doi: 10.1136/bmj.m4447.
18. Hintenberger R, Affenzeller B, Vladychuk V, Pieringer H. Cardiovascular risk in axial spondyloarthritis-a systematic review. Clin Rheumatol. 2023;42(10):2621-33. doi: 10.1007/s10067-023-06655-z.

19. Shen B, Zhang A, Liu J, Da Z, Xu X, Liu H, et al. Body image disturbance and quality of life in Chinese patients with ankylosing spondylitis. Psychol Psychother. 2014;87(3):324-37. doi: 10.1111/papt.12016.
20. Frede N, Rieger E, Lorenzetti R, Venhoff AC, Kanne AM, Finzel S, et al. Sleep behaviour differs in women and men with psoriatic arthritis and axial spondyloarthritis with impact on quality of life and depressive symptoms. RMD Open. 2023;9(2). doi: 10.1136/rmdopen-2022-002912.
21. Xu X, Shen B, Zhang A, Liu J, Da Z, Liu H, Gu Z. Anxiety and depression correlate with disease and quality-of-life parameters in Chinese patients with ankylosing spondylitis. Patient Prefer Adherence. 2016;10:879-85. doi: 10.2147/ppa.S86612.
22. Cakar E, Taskaynatan MA, Dincer U, Kiralp MZ, Durmus O, Ozgül A. Work disability in ankylosing spondylitis: differences among working and work-disabled patients. Clin Rheumatol. 2009;28(11):1309-14. doi: 10.1007/s10067-009-1249-1.
23. Kwan YH, Fong W, Tan VIC, Lui NL, Malhotra R, Østbye T, Thumboo J. A systematic review of quality-of-life domains and items relevant to patients with spondyloarthritis. Semin Arthritis Rheum. 2017;47(2):175-82. doi: 10.1016/j.semarthrit.2017.04.002.
24. Nikiphorou E, Ramiro S. Work Disability in Axial Spondyloarthritis. Curr Rheumatol Rep. 2020;22(9):55. doi: 10.1007/s11926-020-00932-5.
25. Toussirot E. Advances in pharmacotherapies for axial spondyloarthritis. Expert Opinion on Pharmacotherapy. 2023;24(13):1439-48. doi: 10.1080/14656566.2023.2226328.
26. O'Dwyer T, O'Shea F, Wilson F. Exercise therapy for spondyloarthritis: a systematic review. Rheumatol Int. 2014;34(7):887-902. doi: 10.1007/s00296-014-2965-7.
27. Aytekin E, Caglar NS, Ozgonenel L, Tutun S, Demiryontar DY, Demir SE. Home-based exercise therapy in patients with ankylosing spondylitis: effects on pain, mobility, disease activity, quality of life, and respiratory functions. Clin Rheumatol. 2012;31(1):91-7. doi: 10.1007/s10067-011-1791-5.
28. Liang H, Zhang H, Ji H, Wang C. Effects of home-based exercise intervention on health-related quality of life for patients with ankylosing spondylitis: a meta-analysis. Clinical Rheumatology. 2015;34(10):1737-44. doi: 10.1007/s10067-015-2913-2.
29. Ramiro S, Nikiphorou E, Sepriano A, Ortolan A, Webers C, Baraliakos X, et al. ASAS-EULAR recommendations for the management of axial spondyloarthritis: 2022 update. Annals of the Rheumatic Diseases. 2023;82(1):19. doi: 10.1136/ard-2022-223296.
30. Hu X, Chen J, Tang W, Chen W, Sang Y, Jia L. Effects of exercise programmes on pain, disease activity and function in ankylosing spondylitis: A meta-analysis of randomized controlled trials. Eur J Clin Invest. 2020;50(12):e13352. doi: 10.1111/eci.13352.
31. Hidding A, van der Linden S, de Witte L. Therapeutic effects of individual physical therapy in ankylosing spondylitis related to duration of disease. Clin Rheumatol. 1993;12(3):334-40. doi: 10.1007/bf02231574.
32. Millner JR, Barron JS, Beinke KM, Butterworth RH, Chasle BE, Dutton LJ, et al. Exercise for ankylosing spondylitis: An evidence-based consensus statement. Seminars in Arthritis and Rheumatism. 2016;45(4):411-27. doi: https://doi.org/10.1016/j.semarthrit.2015.08.003.
33. Hilberdink B, van der Giesen F, Vliet Vlieland T, Nijkamp M, van Weely S. How to optimize exercise behavior in axial spondyloarthritis? Results of an intervention mapping study. Patient Education and Counseling. 2020;103(5):952-9. doi: https://doi.org/10.1016/j.pec.2019.12.017.
34. Passalent LA, Soever LJ, O'Shea FD, Inman RD. Exercise in ankylosing spondylitis: discrepancies between recommendations and reality. J Rheumatol. 2010;37(4):835-41. doi: 10.3899/jrheum.090655.
35. Sundstrom B, Ekergård H, Sundelin G. Exercise habits among patients with ankylosing spondylitis. Scandinavian Journal of Rheumatology. 2002;31(3):163-7. doi: 10.1080/rhe.31.3.163.167.
36. Veldhuijzen van Zanten JJ, Rouse PC, Hale ED, Ntoumanis N, Metsios GS, Duda JL, Kitas GD. Perceived Barriers, Facilitators and Benefits for Regular Physical Activity and Exercise in Patients with Rheumatoid Arthritis: A Review of the Literature. Sports Med. 2015;45(10):1401-12. doi: 10.1007/s40279-015-0363-2.

37. Staples C, Palermo M, Rancourt D. Intrinsic and extrinsic motivations as moderators of the association between exercise frequency and exercise behavior. Eating and Weight Disorders - Studies on Anorexia, Bulimia and Obesity. 2022;27(7):2801-9. doi: 10.1007/s40519-022-01430-6.
38. Morris LS, Grehl MM, Rutter SB, Mehta M, Westwater ML. On what motivates us: a detailed review of intrinsic v. extrinsic motivation. Psychol Med. 2022;52(10):1801-16. doi: 10.1017/s0033291722001611.
39. Sundström B, Ekergård H, Sundelin G. Exercise habits among patients with ankylosing spondylitis. A questionnaire based survey in the County of Västerbotten, Sweden. Scand J Rheumatol. 2002;31(3):163-7. doi.
40. Schultheis MT, Rizzo AA. The application of virtual reality technology in rehabilitation. Rehabilitation Psychology. 2001;46(3):296-311. doi: 10.1037/0090-5550.46.3.296.
41. Hajesmaeel Gohari S, Gozali E, Niakan Kalhori SR. Virtual reality applications for chronic conditions management: A review. Med J Islam Repub Iran. 2019;33:67. doi: 10.34171/mjiri.33.67.
42. Kim M, Jeon C, Kim J. A Study on Immersion and Presence of a Portable Hand Haptic System for Immersive Virtual Reality. Sensors (Basel). 2017;17(5). doi: 10.3390/s17051141.
43. Patil V, Narayan J, Sandhu K, Dwivedy SK. Integration of Virtual Reality and Augmented Reality in Physical Rehabilitation: A State-of-the-Art Review. In: Subburaj K, Sandhu K, Ćuković S, editors. Revolutions in Product Design for Healthcare: Advances in Product Design and Design Methods for Healthcare. Singapore: Springer Singapore; 2022. p. 177-205.
44. Peng X, Menhas R, Dai J, Younas M. The COVID-19 Pandemic and Overall Wellbeing: Mediating Role of Virtual Reality Fitness for Physical-Psychological Health and Physical Activity. Psychol Res Behav Manag. 2022;15:1741-56. doi: 10.2147/prbm.S369020.
45. Ahmadpour N, Calvo R, Ijaz K. Player Experience of Needs Satisfaction (PENS) in an Immersive Virtual Reality Exercise Platform Describes Motivation and Enjoyment. International Journal of Human-Computer Interaction. 2020;36:1195-204. doi: 10.1080/10447318.2020.1726107.
46. Matsangidou M, Ang CS, Mauger AR, Otkhmezuri B, Tabbaa L, editors. How Real Is Unreal?2017; Cham: Springer International Publishing.
47. Karahan AY, Tok F, Yildirim P, Ordahan B, Turkoglu G, Sahin N. The Effectiveness of Exergames in Patients with Ankylosing Spondylitis: A Randomized Controlled Trial. Adv Clin Exp Med. 2016;25(5):931-6. doi: 10.17219/acem/32590.
48. Gao Z, Lee JE. Emerging Technology in Promoting Physical Activity and Health: Challenges and Opportunities. J Clin Med. 2019;8(11). doi: 10.3390/jcm8111830.
49. Lewis BA, Williams DM, Frayeh A, Marcus BH. Self-efficacy versus perceived enjoyment as predictors of physical activity behaviour. Psychology & Health. 2016;31(4):456-69. doi: 10.1080/08870446.2015.1111372.
50. Dębska M, Polechoński J, Mynarski A, Polechoński P. Enjoyment and Intensity of Physical Activity in Immersive Virtual Reality Performed on Innovative Training Devices in Compliance with Recommendations for Health. Int J Environ Res Public Health. 2019;16(19). doi: 10.3390/ijerph16193673.
51. Hamad A, Jia B. How Virtual Reality Technology Has Changed Our Lives: An Overview of the Current and Potential Applications and Limitations. Int J Environ Res Public Health. 2022;19(18). doi: 10.3390/ijerph191811278.
52. Oinas-Kukkonen H, Harjumaa M. Persuasive Systems Design: Key Issues, Process Model, and System Features. Communications of the Association for Information Systems. 2009;24. doi: 10.17705/1CAIS.02428.
53. Sturm J. Persuasive Technology. In: van Hoof J, Demiris G, Wouters EJM, editors. Handbook of Smart Homes, Health Care and Well-Being. Cham: Springer International Publishing; 2017. p. 3-12.
54. Asmah A, Ofoeda J, Agbozo E, editors. An Analysis of the Persuasive Technology Design Features that Support Behavioural Change2022; Cham: Springer International Publishing.
55. Aldenaini N, Alqahtani F, Orji R, Sampalli S. Trends in Persuasive Technologies for Physical Activity and Sedentary Behavior: A Systematic Review. Frontiers in Artificial Intelligence. 2020;3. doi: 10.3389/frai.2020.00007.

56. Geuens J, Swinnen TW, Westhovens R, de Vlam K, Geurts L, Vanden Abeele V. A Review of Persuasive Principles in Mobile Apps for Chronic Arthritis Patients: Opportunities for Improvement. JMIR Mhealth Uhealth. 2016;4(4):e118. doi: 10.2196/mhealth.6286.
57. Pekyavas NO, Ergun N. Comparison of virtual reality exergaming and home exercise programs in patients with subacromial impingement syndrome and scapular dyskinesis: Short term effect. Acta Orthop Traumatol Turc. 2017;51(3):238-42. doi: 10.1016/j.aott.2017.03.008.
58. Bareišytė L. Using Virtual Reality to Improve Subjective Vitality : Design and Pilot Study for a Virtual Nature Environment. 2021.
59. Mouatt B, Smith AE, Mellow ML, Parfitt G, Smith RT, Stanton TR. The Use of Virtual Reality to Influence Motivation, Affect, Enjoyment, and Engagement During Exercise: A Scoping Review. Frontiers in Virtual Reality. 2020;1. doi: 10.3389/frvir.2020.564664.
60. Pina Gonçalves N, Emília Santos M, Silvério-António M, Donato H, Pimentel-Santos FM, Cruz E. The effects of physical exercise on axial spondyloarthritis - a systematic review. ARP Rheumatol. 2023. doi.
61. Singh J, Metri K, Tekur P, Mohanty S, Singh A, Raghuram N. Tele-yoga in the management of ankylosing spondylitis amidst COVID pandemic: A prospective randomized controlled trial. Complement Ther Clin Pract. 2023;50:101672. doi: 10.1016/j.ctcp.2022.101672.
62. Ramiro S, Nikiphorou E, Sepriano A, Ortolan A, Webers C, Baraliakos X, et al. ASAS-EULAR recommendations for the management of axial spondyloarthritis: 2022 update. Annals of the Rheumatic Diseases. 2023;82(1):19-34. doi: 10.1136/ard-2022-223296.
63. Franke M. The feasibility of virtual reality as exercise therapy for axial spondyloarthritis in a home and a physiotherapy setting (a mixed method study, from a multi-disciplinary perspective). 2024.
64. Venkatesh V, Thong JYL, Xu X. Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology. MIS Quarterly. 2012;36(1):157-78. doi: 10.2307/41410412.
65. Nurtsch A, Teufel M, Jahre LM, Esber A, Rausch R, Tewes M, et al. Drivers and barriers of patients' acceptance of video consultation in cancer care. Digit Health. 2024;10:20552076231222108. doi: 10.1177/20552076231222108.
66. Tugiman T, Herman H, Yudhana A. The UTAUT Model for Measuring Acceptance of the Application of the Patient Registration System. MATRIK : Jurnal Manajemen, Teknik Informatika dan Rekayasa Komputer. 2023;22(2):381-92. doi: https://doi.org/10.30812/matrik.v22i2.2844.
67. Bracq MS, Michinov E, Arnaldi B, Caillaud B, Gibaud B, Gouranton V, Jannin P. Learning procedural skills with a virtual reality simulator: An acceptability study. Nurse Educ Today. 2019;79:153-60. doi: 10.1016/j.nedt.2019.05.026.
68. Greenhalgh T, Abimbola S. The NASSS Framework - A Synthesis of Multiple Theories of Technology Implementation. Stud Health Technol Inform. 2019;263:193-204. doi: 10.3233/shti190123.
69. Dyb K, Berntsen GR, Kvam L. Adopt, adapt, or abandon technology-supported person-centred care initiatives: healthcare providers' beliefs matter. BMC Health Services Research. 2021;21(1):240. doi: 10.1186/s12913-021-06262-1.
70. Keel S, Schmid A, Keller F, Schoeb V. Investigating the use of digital health tools in physiotherapy: facilitators and barriers. Physiotherapy Theory and Practice. 2023;39(7):1449-68. doi: 10.1080/09593985.2022.2042439.
71. Kouijzer M, Kip H, Bouman YHA, Kelders SM. Implementation of virtual reality in healthcare: a scoping review on the implementation process of virtual reality in various healthcare settings. Implement Sci Commun. 2023;4(1):67. doi: 10.1186/s43058-023-00442-2.
72. Rogers EM. Diffusion of Innovations, 5th Edition: Free Press; 2003.
73. Henrich M, Kleespies MW, Dierkes PW, Formella-Zimmermann S. Inclusion of technology affinity in self scale–Development and evaluation of a single item measurement instrument for technology affinity. Frontiers in Education. 2022;7. doi: 10.3389/feduc.2022.970212.

74. Ursavaş ÖF. Technology Acceptance Model: History, Theory, and Application. In: Ursavaş ÖF, editor. Conducting Technology Acceptance Research in Education : Theory, Models, Implementation, and Analysis. Cham: Springer International Publishing; 2022. p. 57-91.
75. Reale C, Speir RC, Ruark K, Herout J, Slagle JM, Weinger MB, Anders SH. Using Scenarios Throughout The User-Centered Design Process in Healthcare. Proceedings of the Human Factors and Ergonomics Society Annual Meeting. 2018;62:610 - 4. doi.
76. Békés V, Doorn KA-v, Bőthe B. Assessing patients' attitudes towards telepsychotherapy: The development of the unified theory of acceptance and use of technology-patient version. Clinical Psychology & Psychotherapy. 2022;29(6):1918-27. doi: https://doi.org/10.1002/cpp.2760.
77. van der Ham IJM, van der Vaart R, Miedema A, Visser-Meily JMA, van der Kuil MNA. Healthcare Professionals' Acceptance of Digital Cognitive Rehabilitation. Frontiers in Psychology. 2020;11. doi: 10.3389/fpsyg.2020.617886.
78. Schomakers EM, Lidynia C, Vervier LS, Calero Valdez A, Ziefle M. Applying an Extended UTAUT2 Model to Explain User Acceptance of Lifestyle and Therapy Mobile Health Apps: Survey Study. JMIR Mhealth Uhealth. 2022;10(1):e27095. doi: 10.2196/27095.
79. Tavakol M, Dennick R. Making sense of Cronbach's alpha. Int J Med Educ. 2011;2:53-5. doi: 10.5116/ijme.4dfb.8dfd.
80. Schreiweis B, Pobiruchin M, Strotbaum V, Suleder J, Wiesner M, Bergh B. Barriers and Facilitators to the Implementation of eHealth Services: Systematic Literature Analysis. J Med Internet Res. 2019;21(11):e14197. doi: 10.2196/14197.
81. Dearing JW, Cox JG. Diffusion Of Innovations Theory, Principles, And Practice. Health Aff (Millwood). 2018;37(2):183-90. doi: 10.1377/hlthaff.2017.1104.
82. Venkatesh V, Morris MG, Davis GB, Davis FD. User Acceptance of Information Technology: Toward a Unified View. MIS Quarterly. 2003;27(3):425-78. doi: 10.2307/30036540.
83. Cobern W, Adams BA. When interviewing: how many is enough? International Journal of Assessment Tools in Education. 2020;7:73-9. doi: 10.21449/ijate.693217.
84. Bowen DJ, Kreuter M, Spring B, Cofta-Woerpel L, Linnan L, Weiner D, et al. How we design feasibility studies. Am J Prev Med. 2009;36(5):452-7. doi: 10.1016/j.amepre.2009.02.002.
85. Castro JW, Madrigal G, Rojas LA, editors. Usability Evaluation Techniques for Virtual Environments: An Exploratory Study. Social Computing and Social Media; 2023 2023//; Cham: Springer Nature Switzerland.
86. Schwind V, Knierim P, Haas N, Henze N. Using Presence Questionnaires in Virtual Reality. Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems; Glasgow, Scotland Uk: Association for Computing Machinery; 2019. p. Paper 360.
87. Berkman MI, Akan E. Presence and Immersion in Virtual Reality. In: Lee N, editor. Encyclopedia of Computer Graphics and Games. Cham: Springer International Publishing; 2019. p. 1-10.
88. igroup presence questionnaire (IPQ) Scale Construction 2016 [Available from: https://www.igroup.org/pq/ipq/construction.php
89. Chang E, Kim HT, Yoo B. Virtual Reality Sickness: A Review of Causes and Measurements. International Journal of Human–Computer Interaction. 2020;36(17):1658-82. doi: 10.1080/10447318.2020.1778351.
90. Somrak A, Pogačnik M, Guna J. Suitability and Comparison of Questionnaires Assessing Virtual Reality-Induced Symptoms and Effects and User Experience in Virtual Environments. Sensors (Basel). 2021;21(4). doi: 10.3390/s21041185.
91. Hyzy M, Bond R, Mulvenna M, Bai L, Dix A, Leigh S, Hunt S. System Usability Scale Benchmarking for Digital Health Apps: Meta-analysis. JMIR Mhealth Uhealth. 2022;10(8):e37290. doi: 10.2196/37290.
92. Castro JW, Madrigal G, Rojas LA, editors. Usability Evaluation Techniques for Virtual Environments: An Exploratory Study2023; Cham: Springer Nature Switzerland.
93. Ensink CJ, Keijsers NLW, Groen BE. Translation and validation of the System Usability Scale to a Dutch version: D-SUS. Disabil Rehabil. 2024;46(2):395-400. doi: 10.1080/09638288.2022.2160837.

94. Cheong C, Filippou J, Cheong F, Pirker J, Gütl C, editors. Using Persuasive System Design Principles to Evaluate Two Next Generation Digital Learning Environments2017; Cham: Springer International Publishing.
95. Matthews J, Win KT, Oinas-Kukkonen H, Freeman M. Persuasive Technology in Mobile Applications Promoting Physical Activity: a Systematic Review. Journal of Medical Systems. 2016;40(3):72. doi: 10.1007/s10916-015-0425-x.
96. Melo M, Gonçalves G, Monteiro P, Coelho H, Vasconcelos-Raposo J, Bessa M. Do Multisensory Stimuli Benefit the Virtual Reality Experience? A Systematic Review. IEEE Transactions on Visualization and Computer Graphics. 2022;28(2):1428-42. doi: 10.1109/TVCG.2020.3010088.
97. Berenbaum F, Chauvin P, Hudry C, Mathoret-Philibert F, Poussiere M, De Chalus T, et al. Fears and beliefs in rheumatoid arthritis and spondyloarthritis: a qualitative study. PLoS One. 2014;9(12):e114350. doi: 10.1371/journal.pone.0114350.
98. Hoffman HG, Sharar SR, Coda B, Everett JJ, Ciol M, Richards T, Patterson DR. Manipulating presence influences the magnitude of virtual reality analgesia. Pain. 2004;111(1-2):162-8. doi: 10.1016/j.pain.2004.06.013.
99. Opara M, Kozinc Ž. Virtual reality training for management of chronic neck pain: a systematic review with meta-analysis. European Journal of Physiotherapy.1-13. doi: 10.1080/21679169.2023.2215831.
100. Mallari B, Spaeth EK, Goh H, Boyd BS. Virtual reality as an analgesic for acute and chronic pain in adults: a systematic review and meta-analysis. J Pain Res. 2019;12:2053-85. doi: 10.2147/jpr.S200498.
101. Ioannou A, Papastavrou E, Avraamides MN, Charalambous A. Virtual Reality and Symptoms Management of Anxiety, Depression, Fatigue, and Pain: A Systematic Review. SAGE Open Nursing. 2020;6:2377960820936163. doi: 10.1177/2377960820936163.
102. Bally ELS, Cheng D, van Grieken A, Ferri Sanz M, Zanutto O, Carroll A, et al. Patients' Perspectives Regarding Digital Health Technology to Support Self-management and Improve Integrated Stroke Care: Qualitative Interview Study. J Med Internet Res. 2023;25:e42556. doi: 10.2196/42556.
103. Lier EJ, Smits MLM, de Vries M, van Goor H. Self-Administered Virtual Reality for Postsurgical Pain Management: A Qualitative Study of Hospital Patients' Reported Experiences. J Clin Med. 2023;12(21). doi: 10.3390/jcm12216805.
104. Offermann J, Wilkowska W, Laurentius T, Bollheimer LC, Ziefle M. How age and health status impact attitudes towards aging and technologies in care: a quantitative analysis. BMC Geriatr. 2024;24(1):9. doi: 10.1186/s12877-023-04616-4.
105. Slatman S, Staal JB, van Goor H, Ostelo R, Soer R, Knoop J. Limited use of virtual reality in primary care physiotherapy for patients with chronic pain. BMC Musculoskeletal Disorders. 2024;25(1):168. doi: 10.1186/s12891-024-07285-5.
106. Kiltz U, Kempin R, Richter J, Schlegel A, Baraliakos X, Tsiami S, et al. Self-monitoring of Disease Activity with a Smartphone App Is Feasible in Routine Clinical Management of Patients with Axial Spondyloarthritis – a Proof of Concept Study. Arthritis Rheumatol. 2021;73(suppl 9). doi.
107. Raquel Costa-Brito A, Bovolini A, Rúa-Alonso M, Vaz C, Francisco Ortega-Morán J, Blas Pagador J, Vila-Chã C. Home-based exercise interventions delivered by technology in older adults: A scoping review of technological tools usage. International Journal of Medical Informatics. 2024;181:105287. doi: https://doi.org/10.1016/j.ijmedinf.2023.105287.
108. Mace RA, Mattos MK, Vranceanu A-M. Older adults can use technology: why healthcare professionals must overcome ageism in digital health. Translational Behavioral Medicine. 2022;12(12):1102-5. doi: 10.1093/tbm/ibac070.
109. Healy D, Flynn A, Conlan O, McSharry J, Walsh J. Older Adults' Experiences and Perceptions of Immersive Virtual Reality: Systematic Review and Thematic Synthesis. JMIR Serious Games. 2022;10(4):e35802. doi: 10.2196/35802.

110. Stewart RE, Beidas RS, Mandell DS. Stop Calling Them Laggards: Strategies for Encouraging Nonadopters to Incorporate Evidence-Based Practices. Psychiatr Serv. 2019;70(10):958-60. doi: 10.1176/appi.ps.201900031.
111. Jamoom EW, Patel V, Furukawa MF, King J. EHR adopters vs. non-adopters: Impacts of, barriers to, and federal initiatives for EHR adoption. Healthc (Amst). 2014;2(1):33-9. doi: 10.1016/j.hjdsi.2013.12.004.
112. van der Horst-Bruinsma IE, Franssen MJAM, Oostveen JCM, van Denderen JC, Leijsma MK, de Sonnaville PBJ, et al. Richtlijn voor de diagnostiek en behandeling van Ankyloserende Spondylitis. Amsterdam; Nijmegen; Almelo; Groningen; Goes; Maastricht: VU medisch centrum; St Maartenskliniek; Twenteborg Ziekenhuis; Jan van Breemen Instituut; UMC Groningen; Oosterscheldeziekenhuis; AZM.
113. Zernicke J, Kedor C, Müller A, Burmester GR, Reißhauer A, Feist E. A prospective pilot study to evaluate an animated home-based physical exercise program as a treatment option for patients with rheumatoid arthritis. BMC Musculoskelet Disord. 2016;17(1):351. doi: 10.1186/s12891-016-1208-3.
114. Tokgöz P, Stampa S, Wähnert D, Vordemvenne T, Dockweiler C. Virtual Reality in the Rehabilitation of Patients with Injuries and Diseases of Upper Extremities. Healthcare (Basel). 2022;10(6). doi: 10.3390/healthcare10061124.
115. Faber M, Andersen MH, Sevel C, Thorborg K, Bandholm T, Rathleff M. The majority are not performing home-exercises correctly two weeks after their initial instruction—an assessor-blinded study. PeerJ. 2015;3:e1102. doi: 10.7717/peerj.1102.
116. Brady N, Dejaco B, Lewis J, McCreesh K, McVeigh JG. Physiotherapist beliefs and perspectives on virtual reality supported rehabilitation for the management of musculoskeletal shoulder pain: A focus group study. PLOS ONE. 2023;18(4):e0284445. doi: 10.1371/journal.pone.0284445.
117. Cai S, Deng D, Wen J, Chen C, Ming Z, Shan Z, editors. Research on Arm Motion Capture of Virtual Reality Based on Kinematics2018; Cham: Springer International Publishing.
118. Blum J, Rockstroh C, Göritz AS. Development and Pilot Test of a Virtual Reality Respiratory Biofeedback Approach. Applied Psychophysiology and Biofeedback. 2020;45:153-63. doi: 10.1007/s10484-020-09468-x.
119. Cao M, Xie T, Chen Z. Wearable Sensors and Equipment in VR Games: A Review. In: Pan Z, Cheok AD, Müller W, Zhang M, El Rhalibi A, Kifayat K, editors. Transactions on Edutainment XV. Berlin, Heidelberg: Springer Berlin Heidelberg; 2019. p. 3-12.
120. Mazeas A, Duclos M, Pereira B, Chalabaev A. Evaluating the Effectiveness of Gamification on Physical Activity: Systematic Review and Meta-analysis of Randomized Controlled Trials. J Med Internet Res. 2022;24(1):e26779. doi: 10.2196/26779.
121. Vansteenkiste M, Ryan RM, Soenens B. Basic psychological need theory: Advancements, critical themes, and future directions. Motivation and Emotion. 2020;44(1):1-31. doi: 10.1007/s11031-019-09818-1.
122. Patrick H, Williams GC. Self-determination theory: its application to health behavior and complementarity with motivational interviewing. Int J Behav Nutr Phys Act. 2012;9:18. doi: 10.1186/1479-5868-9-18.
123. Wee S-C, Choong W-W. Gamification: Predicting the effectiveness of variety game design elements to intrinsically motivate users' energy conservation behaviour. Journal of Environmental Management. 2019;233:97-106. doi: https://doi.org/10.1016/j.jenvman.2018.11.127.
124. Cai RA, Beste D, Chaplin H, Varakliotis S, Suffield L, Josephs F, et al. Developing and Evaluating JIApp: Acceptability and Usability of a Smartphone App System to Improve Self-Management in Young People With Juvenile Idiopathic Arthritis. JMIR Mhealth Uhealth. 2017;5(8):e121. doi: 10.2196/mhealth.7229.
125. Bandura A. Health promotion by social cognitive means. Health Educ Behav. 2004;31(2):143-64. doi: 10.1177/1090198104263660.
126. Abhari K, Klase M, Koobchehr F, Olivares F, Pesavento M, Sosa L, Vaghefi I, editors. Toward a Theory of Digital Mindfulness: A Case of Smartphone-Based Self-monitoring2021; Cham: Springer International Publishing.

127. Kempin R, Richter JG, Schlegel A, Baraliakos X, Tsiami S, Buehring B, et al. Monitoring of Disease Activity With a Smartphone App in Routine Clinical Care in Patients With Axial Spondyloarthritis. J Rheumatol. 2022;49(8):878-84. doi: 10.3899/jrheum.211116.
128. Labinsky H, May S, Boy K, von Rohr S, Grahammer M, Kuhn S, et al. Evaluation of a hybrid telehealth care pathway for patients with axial spondyloarthritis including self-sampling at home: results of a longitudinal proof-of-concept mixed-methods study (TeleSpactive). Rheumatol Int. 2024. doi: 10.1007/s00296-024-05581-w.
129. Liu LHMDMPH, Garrett SBP, Li JMPH, Ragouzeos DMFA, Berrean BMBAMLS, Dohan DP, et al. Patient and clinician perspectives on a patient-facing dashboard that visualizes patient reported outcomes in rheumatoid arthritis. Wiley. 2020. doi: 10.1111/hex.13057.
130. Fu H, McMahon SK, Gross CR, Adam TJ, Wyman JF. Usability and clinical efficacy of diabetes mobile applications for adults with type 2 diabetes: A systematic review. Diabetes Res Clin Pract. 2017;131:70-81. doi: 10.1016/j.diabres.2017.06.016.
131. Seppen BF, Wiegel J, L'ami MJ, Duarte dos Santos Rico S, Catarinella FS, Turkstra F, et al. Feasibility of Self-Monitoring Rheumatoid Arthritis With a Smartphone App: Results of Two Mixed-Methods Pilot Studies. JMIR Form Res. 2020;4(9):e20165. doi: 10.2196/20165.
132. Barnett R, Sengupta R. The Future of Axial Spondyloarthritis Rehabilitation: Lessons Learned From COVID-19. Arthritis Care Res (Hoboken). 2022;74(1):44-9. doi: 10.1002/acr.24780.
133. Kouijzer MMTE, Kip H, Bouman YHA, Kelders SM. Implementation of virtual reality in healthcare: a scoping review on the implementation process of virtual reality in various healthcare settings. Implementation Science Communications. 2023;4(67). doi: 10.1186/s43058-023-00442-2.
134. Jansen-Kosterink S, Broekhuis M, van Velsen L. Time to act mature-Gearing eHealth evaluations towards technology readiness levels. Digit Health. 2022;8:20552076221113396. doi: 10.1177/20552076221113396.
135. van Gemert-Pijnen JE, Nijland N, van Limburg M, Ossebaard HC, Kelders SM, Eysenbach G, Seydel ER. A Holistic Framework to Improve the Uptake and Impact of eHealth Technologies. J Med Internet Res. 2011;13(4):e111. doi: 10.2196/jmir.1672.
136. Tamilmani K, Rana NP, Wamba SF, Dwivedi R. The extended Unified Theory of Acceptance and Use of Technology (UTAUT2): A systematic literature review and theory evaluation. International Journal of Information Management. 2021;57:102269. doi: https://doi.org/10.1016/j.ijinfomgt.2020.102269.
137. Schomakers E-M, Lidynia C, Vervier LS, Calero Valdez A, Ziefle M. Applying an Extended UTAUT2 Model to Explain User Acceptance of Lifestyle and Therapy Mobile Health Apps: Survey Study. JMIR Mhealth Uhealth. 2022;10(1):e27095. doi: 10.2196/27095.
138. Hardy S, Dutz T, Wiemeyer J, Göbel S, Steinmetz R. Framework for personalized and adaptive game-based training programs in health sport. Multimedia Tools and Applications. 2015;74(14):5289-311. doi: 10.1007/s11042-014-2009-z.
139. Orji R, Oyibo K, Tondello G. A Comparison of System-Controlled and User-Controlled Personalization Approaches2017.
140. Michie S, Richardson M, Johnston M, Abraham C, Francis J, Hardeman W, et al. The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. Ann Behav Med. 2013;46(1):81-95. doi: 10.1007/s12160-013-9486-6.
141. Michie S, Abraham C, Whittington C, McAteer J, Gupta S. Effective techniques in healthy eating and physical activity interventions: a meta-regression. Health Psychol. 2009;28(6):690-701. doi: 10.1037/a0016136.
142. Greenhalgh T, Wherton J, Papoutsi C, Lynch J, Hughes G, A'Court C, et al. Beyond Adoption: A New Framework for Theorizing and Evaluating Nonadoption, Abandonment, and Challenges to the Scale-Up, Spread, and Sustainability of Health and Care Technologies. J Med Internet Res. 2017;19(11):e367. doi: 10.2196/jmir.8775.

143. Saskia M Kelders 1 RNK, Hans C Ossebaard, Julia E W C Van Gemert-Pijnen. Persuasive system design does matter: a systematic review of adherence to web-based interventions - PubMed. Journal of medical Internet research. 11/14/2012;14(6). doi: 10.2196/jmir.2104.

Appendix 1. Abbreviations

ASAS – assessment of SpondyloArtritis Society
axSpA – axial Spondyloarthritis
bDMARDS – biological disease-modifying antirheumatic drugs
BASDAI – Bath Ankylosing Spondylitis Disease Activity Index
BASFI – Bath Ankylosing Spondylitis Functional Index
BCT – Behaviour Change Technique
BMS – faculty of behavioral, management and social sciences
BI – behavioral intention
CRP – C-reacitve protein
CS – credibility support
DHT - digital health technologies
DS – dialogue support
EE – effort expectancy
EM – extrinsic motivation
ESR – erythrocyte sedimentation rate
EULAR – European League Against Rheumatism
FC – facilitating conditions
FMS – fast motion sickness
HLA-B27 – human leukocyte antigen b27
HCP – healthcare provider
HIX – healthcare information eXchange
HMD – head-Mounted Displays
IBP – inflammatory back pain
IBD – inflammatory bowel disease
IL-23 – interleukin 23
IL-17 – interleukin 17
IL-17i – interleukin-17 inhibitor
IM – intrinsic motivation
IPQ – i-group presence questionnaire
JAKi – janus kinase inhibitors
NASSS – Non-adoption, Abandonment, Scale-up, Spread, and Sustainability
nr-axSpA – non-radiographic axSpA
NSAID - nonsteroidal anti-inflammatory drugs
PA – physical activity
PE – performance expectancy
PROM - patient reported outcome measures
PSD – persuasive system design
PTS – primary task support
RA – rheumatoid arthritis
RCT – randomized controlled trial
r-axSpA – radiographic axSpA
SCT- social cognitive theory
SD – standard deviation
SI – social influences
SI joints – sacroilliac joints
SS – social support

SUS – system usability scale
TAM – technology acceptance model
TNFi - tumor necrosis factor inhibitors
tsDMARDs – targeted synthetic DMARDs
UT – University of Twente
UTAUT - Unified Theory of Acceptance and Use of Technology
VR – Virtual Reality
WN – Walk in Nature

Appendix 2. Correspondance

Appendix 2.1 Mail to patients

Goedemorgen,

Vanuit de afdeling Reumatologie wordt u uitgenodigd om deze vragenlijst in te vullen. Hierin wordt uw mening gevraagd over het gebruik van Virtual Reality als oefentherapie. Het is belangrijk om te weten wat u hiervan vindt. Uw mening helpt ons om te onderzoeken of Virtual Reality in de toekomst kan worden gebruikt als oefentherapie.

Als u mee wilt doen met deze vragenlijst, krijgt u de volgende code: [nummer]. U krijgt deze code zodat uw gegevens anoniem blijven als u de vragenlijst invult. Als u op de onderstaande link klikt, wordt u eerst gevraagd om akkoord te gaan. Daarna kan u de code intypen. Vervolgens krijgt u de vragen te zien.

Wilt u deze vragenlijst invullen? Dan mag u op de volgende link klikken: [link]

Het invullen duurt ongeveer 20 minuten. Uw antwoorden worden alleen gebruikt voor dit onderzoek en worden met niemand gedeeld.

Hartelijk dank voor uw hulp.
Met vriendelijke groet,

Marieke Weenink
HBO Verpleegkundige
Afdeling Reumatologie, MST-ziekenhuis in Enschede
Student Gezondheidswetenschappen

Appendix 2.2 Mail to physiotherapists

Goeiemorgen [naam],

Vanwege het interview volgende week maandag krijg je een enquête toegestuurd. Hierin word je uitgenodigd om enkele demografische gegevens in te vullen. Dit duurt ongeveer 2 minuten. De antwoorden blijven anoniem doordat je in de eerste vraag een nummer invult. Het nummer en de link naar de enquête staan onderaan de mail.

Tevens krijg je een document toegestuurd, hierin staat:

- Uitleg over het virtuele programma;
- 3 korte scenario's. Deze beschrijven hoe het programma door patiënten kan worden gebruikt. Zou je deze scenario's willen doorlezen? Tijdens het interview worden hier vragen over gesteld.

Tenslotte enkele praktische punten:

- Het adres van het gebouw waar het interview plaatsvindt, is **Hallenweg 17, 7522 NH Enschede.**
- Je kan parkeren op de aangegeven cirkel op de plattegrond (P2). De route vanaf de parkeerplaats tot Ravelijn is aangegeven met de rode streep.
- Je mag naar de service balie lopen. Deze zit bij de ingang van het gebouw (de kleine stip op de plattegrond). Ik zal je vanaf daar meenemen naar de ruimte van het interview.
- Mochten er die dag onverhoopt problemen optreden, dan ben ik te bereiken via: [nummer]

Jouw unieke code om in te vullen: [nummer]
Via deze link kun je de enquête invullen: [link enquête]

Mocht je nog vragen hebben, mag je mij gerust een berichtje sturen. Zo niet, dan tot snel!

Met vriendelijke groet,

Marieke Weenink

Appendix 2.3 PIF – Participant Information Form for physiotherapists

INFORMATIE OVER DEELNAME AAN WETENSCHAPPELIJK ONDERZOEK

Titel: Wat is de haalbaarheid van Virtual Reality (VR) als oefentherapie in de fysiotherapiepraktijk voor patiënten met Bechterew?

Onderzoekers: Marieke Weenink, prof. dr. H.E. Vonkeman, prof. C. Bode

Centrum: Medisch Spectrum Twente

Inleiding

Geachte heer/mevrouw,

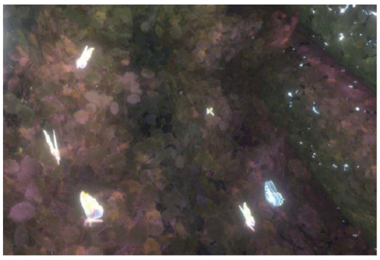
Wij vragen u vriendelijk om mee te doen aan een wetenschappelijk onderzoek (zie titel). In dit onderzoek wordt onderzocht of het doen van fysieke oefeningen met een VR bril in de fysiotherapiepraktijk haalbaar is in de behandeling van Bechterew. U beslist zelf of u wilt meedoen. Voordat u de beslissing neemt, is het belangrijk om meer te weten over het onderzoek. Lees deze informatiebrief rustig door. Bespreek het met uw partner, vrienden of familie.

Heeft u na het lezen van de informatie nog vragen? Dan kunt u terecht bij de onderzoeker. Op bladzijde 3 vindt u deze contactgegevens.

1. Wat is het doel van het onderzoek?

Het doel is om te onderzoeken of het doen van verschillende oefeningen met een VR bril in de fysiotherapiepraktijk haalbaar is als behandeling voor patiënten met Bechterew. Virtual Reality (VR) bestaat uit een digitale wereld waar u in terecht komt door middel van het opzetten van een VR-bril (zie figuur 1). VR lijkt mogelijk effectief te zijn bij het uitvoeren van fysieke oefeningen, maar de haalbaarheid van VR als oefentherapie in de fysiopraktijk voor patiënten met Bechterew is nog niet onderzocht. Daarom wordt het perspectief van de fysiotherapeuten en patiënten gevraagd. Aan de hand van hun mening wordt onderzocht of het verder onderzoeken van VR als oefentherapie voor patiënten met Bechterew een haalbare behandelmethode is.

Figuur 1: de VR bril



Figuur 2: één van de oefeningen

2. Hoe wordt het onderzoek uitgevoerd?

Als u deelneemt aan dit onderzoek zal er een interview worden gehouden. Tijdens het interview krijgt u de gelegenheid om een oefening uit te proberen (zie figuur 2), waarna u wordt gevraagd om een korte vragenlijst in te vullen. Dit zal ongeveer 10 minuten duren. Hierna wordt er een interview afgenomen. Dit zal ongeveer 30 minuten duren.

3. Wat wordt er van u verwacht?

Wanneer u meedoet aan dit onderzoek wordt u binnenkort benaderd voor het inplannen van het interview. Voor het interview wordt u gevraagd naar de Universiteit van Twente te komen. Tijdens de afname van het interview krijgt u de mogelijkheid om de bril uit te proberen en wordt u gevraagd om een korte vragenlijst invullen over het gebruik van de bril. Vervolgens wordt het interview afgenomen, en krijgt u vragen over het gebruik van VR als oefentherapie in de fysiotherapiepraktijk.

4. Wat gebeurt er als u niet wenst deel te nemen aan dit onderzoek?

U beslist zelf of u meedoet aan het onderzoek. Deelname is vrijwillig. Als u besluit niet mee te doen, hoeft u verder niets te doen. U hoeft niets te tekenen. U hoeft ook niet te zeggen waarom u niet wilt meedoen. Als u wel meedoet, kunt u zich altijd bedenken en toch stoppen. Ook tijdens het onderzoek. U hoeft geen reden te geven waarom u wilt stoppen.

5. Wat gebeurt er met uw gegevens?

Voor dit onderzoek worden uw persoonsgegevens gebruikt en bewaard. Het gaat om gegevens zoals uw naam, geboortedatum en om gegevens over uw gezondheid. Het verzamelen, gebruiken en bewaren van uw gegevens is nodig om de vragen die in dit onderzoek worden gesteld te kunnen beantwoorden en de resultaten te kunnen publiceren. Wij vragen voor het gebruik van uw gegevens uw toestemming.

Vertrouwelijkheid van uw gegevens

Om uw privacy te beschermen krijgen uw gegevens een anonieme code. Uw naam en andere gegevens die u direct kunnen identificeren worden daarbij weggelaten. Alleen de hoofdonderzoeker heeft toegang tot de codelijst. Alleen met de sleutel van de code zijn gegevens tot u te herleiden. De sleutel van de code blijft veilig opgeborgen in de lokale onderzoeksinstelling. De gegevens in rapporten en publicaties over het onderzoek zijn niet naar u te herleiden.

Toegang tot uw gegevens voor controle

Sommige personen kunnen op de onderzoekslocatie toegang krijgen tot al uw gegevens. Ook tot de gegevens zonder code. Dit is nodig om te kunnen controleren of het onderzoek goed en betrouwbaar is uitgevoerd. Personen die ter controle inzage krijgen in uw gegevens zijn prof. dr. H. E. Vonkeman, bevoegde medewerkers van dit onderzoek, de Inspectie voor de Gezondheidszorg en controleurs van de Raad van Bestuur van de instelling waar het onderzoek wordt uitgevoerd, nationale en internationale toezichthoudende autoriteiten, bijvoorbeeld de Inspectie Gezondheidszorg en Jeugd. Zij houden uw gegevens geheim. Wij vragen u voor deze inzage toestemming te geven.

Bewaartermijn gegevens

Volgens wettelijke bepalingen zullen uw gegevens 5 jaar worden bewaard in het ziekenhuis. Hierna worden de gegevens vernietigd.

Intrekken toestemming
U kunt uw toestemming voor gebruik van uw persoonsgegevens altijd weer intrekken. De onderzoeksgegevens die zijn verzameld tot het moment dat u uw toestemming intrekt worden nog wel gebruikt in het onderzoek.

Meer informatie over uw rechten bij verwerking van gegevens
Voor algemene informatie over uw rechten bij verwerking van uw persoonsgegevens kunt u de website van de Autoriteit Persoonsgegevens raadplegen. Bij vragen of klachten over de verwerking van uw persoonsgegevens raden we u aan eerst contact op te nemen met het ziekenhuis. U kunt ook contact opnemen met de Functionaris voor de Gegevensbescherming van de instelling [zie bijlage A].

6. Zijn er extra kosten of krijgt u een vergoeding wanneer u besluit aan dit onderzoek mee te doen?
Er worden alleen de kosten voor de ziekenhuisbehandeling bij u of uw zorgverzekeraar in rekening gebracht. U maakt geen extra kosten voor het onderzoek.

- Indien u reiskosten moet maken om naar de Universiteit van Twente te komen, worden deze vergoed.

7. Door wie is dit onderzoek goedgekeurd?
De Raad van Bestuur van Medisch Spectrum Twente heeft goedkeuring gegeven om dit onderzoek uit te voeren.

8. Wilt u verder nog iets weten?
Wanneer u na het lezen van deze informatie of tijdens deelname aan dit onderzoek toch vragen heeft kunt u contact opnemen met:

Marieke Weenink, hoofdonderzoeker
06-19438631

Indien u na zorgvuldige overweging besluit deel te nemen aan dit wetenschappelijk onderzoek, dan vragen we u om samen met de onderzoeker het toestemmingsformulier te ondertekenen en van een datum te voorzien.

Met vriendelijke groet,
Marieke Weenink

Bijlage
A: contactgegevens
B: Toestemmingsformulier

Bijlage A: contactgegevens voor Medisch Spectrum Twente

Prof. dr. H.E. Vonkeman, reumatoloog-onderzoeker
Koningsplein 1
7512 KZ Enschede
Te bereiken: maandag t/m vrijdag (8:00-17:00 uur) via telefoonnummer: 053 487 24 50

Mw. M. Weenink, student Gezondheidswetenschappen
Te bereiken: maandag t/m vrijdag (8:00-17:00 uur) via telefoonnummer: 06-194 386 31

Klachten: Patiënten servicecentrum
Te bereiken: maandag t/m vrijdag (8:00-17:00 uur) via telefoonnummer: 053 487 24 50

Functionaris voor de Gegevensbescherming van de instelling
Mw. P. van Paridon
Te bereiken maandag t/m vrijdag (8:30-17:00 uur) via telefoonnummer: 06-317 513 87

Bijlage B: Toestemmingsformulier

Wat is de haalbaarheid van Virtual Reality (VR) als oefentherapie in de fysiotherapiepraktijk voor patiënten met Bechterew?

Versie 1.0, datum: 5-11-2023

- ✓ Ik heb de informatiebrief voor deelname aan het onderzoek gelezen. Ik kon aanvullende vragen stellen. Mijn vragen zijn genoeg beantwoord. Ik had genoeg tijd om te beslissen of ik meedoe.

- ✓ Ik weet dat meedoen helemaal vrijwillig is. Ik weet dat ik op ieder moment kan beslissen om toch niet mee te doen. Daarvoor hoef ik geen reden te geven.

- ✓ Ik weet dat sommige mensen mijn gegevens kunnen zien. Die mensen staan vermeld in de informatiebrief.

- ✓ Ik geef toestemming om mijn gegevens te gebruiken, voor de doelen die in de informatiebrief staan.

- ✓ Ik geef toestemming om mijn onderzoeksgegevens 5 jaar na afloop van dit onderzoek te bewaren.

- ✓ Ik wil meedoen aan dit onderzoek.

Naam deelnemer:

Handtekening: Datum: __/ __/ __

Ik verklaar hierbij dat ik deze deelnemer volledig heb geïnformeerd over het genoemde onderzoek. Als er tijdens het onderzoek informatie bekend wordt die de toestemming van de deelnemer zou kunnen beïnvloeden, dan breng ik hem/haar daarvan tijdig op de hoogte.

Naam onderzoeker (of diens vertegenwoordiger):

Handtekening: Datum: __/ __/ __

Aanvullende informatie is gegeven door (indien van toepassing):

Naam:

Functie:

Handtekening: Datum: __/ __/ __

Appendix 3. Surveys

Appendix 3.1 Patient survey

Virtual Reality als oefentherapie bij Bechterew

Welkom bij dit onderzoek over Virtual Reality. Het doel van dit onderzoek, is om in kaart te brengen of Virtual Reality haalbaar is als oefentherapie voor mensen met Bechterew. Uw mening hierover is belangrijk en helpt ons om de behandeling tegen Bechterew te verbeteren.
Dit onderzoek wordt uitgevoerd door de polikliniek Reumatologie van het MST ziekenhuis. Het invullen van de vragenlijst duurt ongeveer 20 minuten. De gegevens uit deze vragenlijst worden anoniem verwerkt. Heeft u vragen of wilt u meer informatie, dan mag u contact opnemen met de hoofdonderzoeker, M. Weenink. Deze gegevens staan in toegezonden mail.

Voor de beste ervaring raden wij u aan om deze vragenlijst op de computer of laptop te beantwoorden.

Door hier onder te kiezen voor 'ik ga akkoord', geeft u aan dat u:

- Weet dat meedoen vrijwillig is.
- Weet dat u op ieder moment kan beslissen om toch niet meer mee te doen. U hoeft hiervoor geen reden te geven.
- Weet dat de hoofdonderzoeker (M. Weenink) gegevens kan inzien die u kunnen identificeren. Met deze gegevens wordt vertrouwelijk omgegaan.
- Toestemming geeft om de gegevens in deze vragenlijst tot 5 jaar na afloop van het onderzoek te bewaren.

○ Ik ga akkoord en wil deze vragenlijst WEL invullen

○ Ik ga NIET akkoord en wil deze vragenlijst NIET invullen

Hartelijk dank dat u wilt mee werken aan het onderzoek over Virtual Reality.

Wij vragen u om hieronder uw nummer in te vullen. Deze staat vermeld in de toegezonden mail.

____

Deel 1/3

De vragenlijst bestaat uit 3 delen. In deel 1 vragen wij u om enkele gegevens in te vullen over uzelf en uw klachten. In deel 2 krijgt u uitleg over Virtual Reality. In deel 3 mag u enkele uitspraken beantwoorden.

Vult u alstublieft de onderstaande vragen in over uzelf.

Wat is uw leeftijd?

____

Wat is uw geslacht?

- ○ Man
- ○ Vrouw
- ○ Non-binar / derde geslacht
- ○ Dat zeg ik liever niet

Wat is uw hoogst behaalde opleiding?

- ○ Geen
- ○ Basisonderwijs
- ○ VMBO
- ○ HAVO/VWO
- ○ Middelbaar beroepsonderwijs (MBO)
- ○ Hoger beroepsonderwijs/ Universiteit (HBO/WO)
- ○ Anders, namelijk: ____

Sinds wanneer heeft u de diagnose Bechterew?

____

Wilt u enkele vragen beantwoorden over uw klachten?

Doet u wel eens oefeningen vanwege uw klachten?

- ○ Ja
- ○ Nee

Waar doet u deze oefeningen?
U kunt meerdere opties aanklikken

- ☐ Thuis
- ☐ Fysiotherapie praktijk
- ☐ Sportschool
- ☐ Anders, namelijk: ____

Hoe vaak doet u deze oefeningen?

- ○ Dagelijks
- ○ 3 tot 5 keer per week
- ○ 1 tot 2 keer per week
- ○ Minder dan 1 keer per week
- ○ Ik doe geen oefeningen

Gaat u wel eens naar de fysiotherapeut voor uw klachten?

- ◯ Ja
- ◯ Nee

Kunt u op de schaal hieronder aangeven hoe tevreden u bent met hoe vaak u oefent?
Een 0 betekent dat u **zeer ontevreden** bent, een 5 betekent dat u niet tevreden en niet ontevreden bent, en een 10 betekent dat u **zeer tevreden** bent.

- ◯ 0 (zeer ontevreden)
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5 (neutraal)
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10 (zeer tevreden)

Wilt u uw vorige antwoord toelichten?

____

Zou u vaker willen oefenen dan u nu doet?

- ◯ Ja
- ◯ Nee

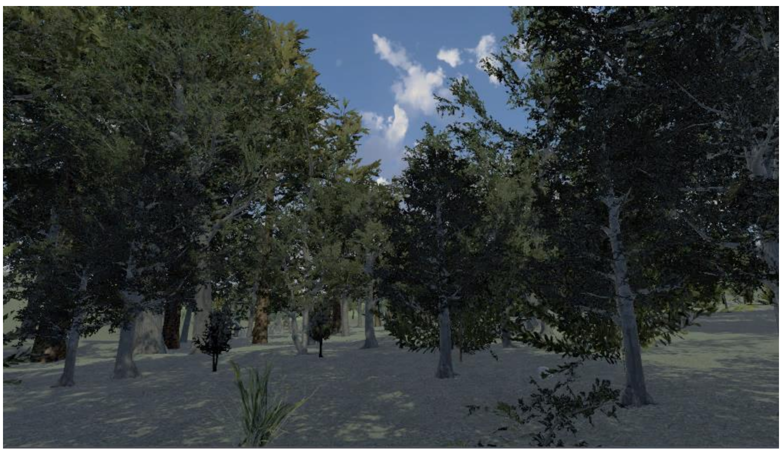
Deel 2/3

Het volgende deel gaat over Virtual Reality. Virtual Reality (VR) is een virtuele, neppe 3D-omgeving waarin u terechtkomt als u een VR-bril op uw hoofd zet (Foto 1). Via het brede scherm in de bril ziet u de virtuele omgeving. Door uw hoofd te bewegen kunt u via dit scherm helemaal om u heen kijken: het lijkt hierdoor alsof u in de virtuele omgeving staat. Op foto 1 zijn de 2 controllers zichtbaar. Deze neemt u in uw handen. Hiermee kunt u dingen aanraken of verplaatsen in de virtuele omgeving.

Een VR-bril kan mogelijk helpen bij reumaklachten, bijvoorbeeld doordat u in deze virtuele omgeving oefeningen kan doen.

Foto 1: De VR-bril met twee controllers

Foto 2: Een voorbeeld van een virtueel bos. Deze ziet u door het scherm in de bril. Doordat u om u heen kan kijken, lijkt het alsof u echt in het bos staat.



U krijgt nu een korte uitleg over het VR programma dat is gemaakt.

Voor dit onderzoek is een programma gemaakt. Dit programma bestaat uit een virtuele, natuurlijke wereld met bomen en planten. **Deze wereld ziet u zodra u de VR-bril op zet.** Ook hoort u dan vogelgeluiden. In het programma kunt u 3 oefeningen volgen: een ademhalingsoefening (foto 1), een vlinderoefening (foto 2) en een yoga oefening (foto 3).

Foto 1: De ademhalingsoefening

Foto 2: De vlinderoefening

Foto 3: De yoga oefening

Er volgen nu 3 korte voorbeelden. Hierin leest u over patiënten die het programma met de oefeningen gebruiken. Daarover krijgt u enkele vragen.

Lees alstublieft het onderstaande voorbeeld

VR thuis in combinatie met fysiotherapie

Dit is Hanna. Ze gaat elke week naar de fysiotherapeut om te oefenen. Maar eigenlijk is Hanna hier te druk voor in haar dagelijks leven. De fysio geeft Hanna een VR-bril mee naar huis. Hanna kan daardoor thuis oefenen wanneer ze er tijd voor heeft. Ze gaat minder vaak naar de fysio.

Hanna hoort en ziet bij elke oefening in de bril een korte uitleg. Dit helpt haar om de bril zelf te gebruiken. Ook is er een virtuele coach. De coach helpt bij de yoga oefening: samen met de coach doet Hanna rek- en strek oefeningen.

De virtuele coach doet een yoga oefening voor

Hanna oefent thuis zelfstandig met de VR-bril. Stel, u mag de VR-bril gebruiken.

Zou u het nuttig vinden om, net als Hanna, thuis oefeningen te doen met de VR-bril?

- ◯ Ja
- ◯ Nee
- ◯ Weet ik niet

Wilt u uw vorige antwoord toelichten?

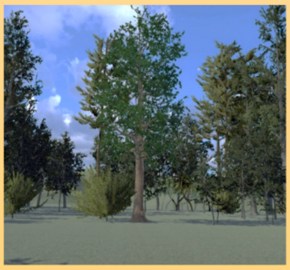
____

Lees alstublieft het onderstaande voorbeeld

Een VR-bril in de fysiotherapie praktijk gebruiken

Dit is Loes. Loes heeft stress door een toename van klachten. De fysiotherapeut adviseert een VR-bril met 3 oefeningen, waaronder een ademhalingsoefening. Loes is onzeker over de VR-bril; ze kent dit niet. Daarom gebruikt Loes de bril in de fysio praktijk. De fysio begeleidt haar. Loes begint met de ademhalingsoefening.

Loes ziet een grote boom voor zich. De boom "ademt" met Loes mee: bij elke ademhaling van Loes wordt de boom groener. De oefening is klaar zodra de boom helemaal groen is. Ook heeft elke oefening een makkelijke en moeilijke versie. Als Loes zich niet goed voelt, kiest ze de makkelijke versie. Zo blijft ze toch oefenen.



De boom die Loes ziet

Loes gebruikt de VR-bril onder begeleiding van de fysiotherapeut in de fysiotherapie praktijk. Stel, u mag de VR-bril gebruiken.
Zou u het nuttig vinden om, net als Loes, in de fysiotherapie praktijk oefeningen te doen met de VR-bril?

- ◯ Ja
- ◯ Nee
- ◯ Weet ik niet

Wilt u uw vorige antwoord toelichten?

____

Zou u de VR-bril liever op een andere locatie willen gebruiken om mee te oefenen? Zo ja, wilt u dan hieronder de gewenste locatie benoemen?

- ◯ Ja, namelijk: ____
- ◯ Nee

Lees alstublieft het laatste voorbeeld.

Vlinder oefening met spel

Dit is Daan. Daan zegt tegen de fysiotherapeut dat hij de oefeningen saai vindt. De fysio weet dat Daan graag computerspellen speelt. Hij stelt voor dat Daan oefent met een VR-bril.

De bril heeft een virtuele 'vlinder' oefening. Daan moet alle vlinders aanraken door te strekken en te buigen. Als Daan klaar is, ziet hij een score. Deze wil hij steeds verbeteren. Hierdoor oefent Daan vaker.

De vlinder oefening

Stel, u mag de VR-bril gebruiken. Welke van de 3 oefeningen die in de verhaaltjes zijn benoemd lijken u nuttig om te doen? U mag meerdere opties aanklikken.

- ☐ De ademhalingsoefening (voorbeeld Loes)
- ☐ De yoga oefening (voorbeeld Hanna)
- ☐ De vlinder oefening (voorbeeld Daan)
- ☐ Geen van de oefeningen

Kunt u aangeven waarom u deze oefeningen nuttig vindt?

____

Welke van de 3 oefeningen die in de verhaaltjes zijn benoemd lijken u niet nuttig om te doen? U mag meerdere opties aanklikken.

- ☐ De ademhalingsoefening (voorbeeld Loes)
- ☐ De yoga oefening (voorbeeld Hanna)
- ☐ De vlinder oefening (voorbeeld Daan)
- ☐ Geen van de oefeningen

Wilt u uw antwoord toelichten?

____

Welke functie(s) in de bril lijkt/lijken u nuttig om te kunnen oefenen? U kunt meerdere opties aanklikken

- ☐ U krijgt te horen (feedback) hoe goed u de oefening heeft uitgevoerd
- ☐ Oefeningen waarbij u makkelijke en moeilijke versies kan kiezen
- ☐ Oefeningen met een spel element (zoals een score)
- ☐ Een help desk met informatie over de bril en het programma
- ☐ Geen functie lijkt mij nuttig

Wilt u uw antwoord toelichten?

____

Welke functie(s) binnen de bril lijkt/lijken u <u>niet</u> nuttig om mee te kunnen oefenen? U kunt meerdere opties aanklikken.

- ☐ U krijgt te horen (feedback) hoe goed u de oefening heeft uitgevoerd
- ☐ Oefeningen waarbij u makkelijke en moeilijke versies kan kiezen
- ☐ Oefeningen met een spel element (zoals een score)
- ☐ Een help desk met informatie over de bril en het programma
- ☐ Geen van de benoemde functies lijkt mij nuttig

Wilt u uw antwoord toelichten?

____

Zijn er redenen waardoor u liever geen VR-bril zou gebruiken om mee te oefenen? Zo ja, zou u deze willen benoemen?

____

Heeft u zelf ervaring met een VR-bril?

- ○ Ja
- ○ Nee

Hieronder staan 5 uitspraken. Kies alstublieft de uitspraak die het beste bij u past.

- ○ Ik ben altijd eerste die nieuwe technologieën gebruikt en loop meestal voor op anderen
- ○ Ik vind het leuk om nieuwe technologieën uit te proberen zodra ze in de winkel liggen
- ○ Ik geef de voorkeur aan een nieuwe technologie als ik zeker weet dat het handig is
- ○ Ik ben niet snel geneigd om nieuwe technologieën uit te proberen. Ik blijf liever bij wat ik ken
- ○ Ik gebruik nieuwe technologieën alleen als het echt nodig is

---

Deel 3/3

Het 'Walk in Nature' programma kunt u doorlopen als u de bril opzet, zoals uitgelegd in de introductie. In dit laatste deel komen een aantal uitspraken aan bod. Klikt u alstublieft verder om deze te zien.

Beoordeel alstublieft de volgende uitspraken.

	Zeer waarschijnlijk	Waarschijnlijk	Neutraal	Onwaarschijnlijk	Zeer onwaarschijnlijk
Ik denk dat het VR programma oefenen leuker kan maken	○	○	○	○	○
Ik denk dat het VR programma mij kan helpen om vaker te oefenen	○	○	○	○	○
Met het VR programma zou ik sneller geneigd zijn om te oefenen	○	○	○	○	○
Ik denk dat het VR programma kan helpen om klachten te verminderen	○	○	○	○	○

Beoordeel alstublieft de volgende uitspraken

	Zeer waarschijnlijk	Waarschijnlijk	Neutraal	Onwaarschijnlijk	Zeer onwaarschijnlijk
Het zou makkelijk voor me zijn om het VR programma te leren gebruiken	○	○	○	○	○
Ik verwacht dat ik snel vaardig kan worden in het gebruiken van het VR programma	○	○	○	○	○
Ik verwacht dat het makkelijk is om het VR programma te gebruiken	○	○	○	○	○

Beoordeel alstublieft de volgende uitspraken

	Zeer waarschijnlijk	Waarschijnlijk	Neutraal	Onwaarschijnlijk	Zeer onwaarschijnlijk
Ik zou het VR programma sneller uitproberen als mijn reumatoloog dit zou aanbevelen	○	○	○	○	○
Ik zou het VR programma sneller uitproberen als ik wist dat andere patiënten er positieve ervaringen mee hebben	○	○	○	○	○
Ik zou het VR programma sneller uitproberen als familie of vrienden dit zouden aanbevelen	○	○	○	○	○

Beoordeel alstublieft de volgende uitspraken

	Zeer waarsc hijnlijk	Waarschijnlijk	Neutraal	Onwaarschijnlijk	Zeer onwaarschijnlijk
Ik verwacht weinig technische hulp nodig te hebben om het VR programma te gebruiken	○	○	○	○	○
Ik verwacht dat ik het VR programma zonder veel hulp kan gebruiken	○	○	○	○	○
Ik verwacht dat er voor mij voldoende hulp beschikbaar zal zijn om het VR programma te leren gebruiken	○	○	○	○	○

Beoordeel alstublieft de laatste uitspraken

	Zeer Waarschijnlijk	Waarschijnlijk	Neutraal	Onwaarschijnlijk	Zeer onwaarschijnlijk
Als ik nu toegang had tot het VR programma, zou ik het willen uitproberen om oefeningen mee te doen	○	○	○	○	○
Ik ben bereid om in de toekomst het VR programma uit te proberen om oefeningen mee te doen	○	○	○	○	○

U bent aan het einde van de vragenlijst gekomen. Door op 'verder' te klikken, worden uw antwoorden verstuurd. Als u uw antwoorden nog een keer wilt doornemen, kunt u op 'terug' klikken. Let u er dan op dat u de enquête juist afrondt door hier terug te komen en op 'verder' te klikken.

Appendix 3.2 Physiotherapist survey - before using the WN program

Vragenlijst voor het interview

Voor dit onderzoek vragen wij u om enkele gegevens in te vullen. Deze gegevens helpen ons om inzicht te krijgen in de haalbaarheid van Virtual Reality (VR) in de fysiotherapie praktijk voor patiënten met axiale Spondylartritis. Het invullen duurt ongeveer 3 minuten. De antwoorden worden anoniem opgeslagen.

Wilt u uw studienummer invullen? Deze staat vermeld in de toegezonden mail.

____

Wat is uw geslacht?

- ○ Man
- ○ Vrouw
- ○ Non-binair/ derde geslacht
- ○ Zeg ik liever niet

Wat is uw leeftijd?

____

Wat is uw hoogst behaalde diploma?

- ○ MBO
- ○ HBO
- ○ WO
- ○ Doctor (PHD)

Wat is uw functie?

____

Wat is uw werkervaring in jaren?

- ○ 0-3 jaar
- ○ 4-6 jaar
- ○ 7-10 jaar
- ○ > 10 jaar

In welk type fysiotherapie praktijk werkt u?

- ○ Ziekenhuis
- ○ Revalidatie centrum
- ○ Particuliere fysiotherapie praktijk
- ○ Anders, namelijk: ____

Heeft u ervaring met Virtual Reality in uw beroep?

- ◯ Ja
- ◯ Nee

Heeft u ervaring met het implementeren van technologie in uw praktijk?

- ◯ Ja
- ◯ Nee

Heeft u ervaring met de doelgroep (axSpA patiënten) in uw beroep?

- ◯ Ja
- ◯ Nee

Hieronder staan 5 uitspraken. Kies alstublieft de uitspraak die het beste bij u past.

- ◯ Ik ben altijd eerste die nieuwe technologieën gebruikt en loop meestal voor op anderen
- ◯ Ik vind het leuk om nieuwe technologieën uit te proberen zodra ze in de winkel liggen
- ◯ Ik geef de voorkeur aan een nieuwe technologie als ik zeker weet dat het handig is
- ◯ Ik ben niet snel geneigd om nieuwe technologieën uit te proberen. Ik blijf liever bij wat ik ken
- ◯ Ik gebruik nieuwe technologieën alleen als het echt nodig is

---

Dit was de laatste vraag die te maken heeft met het onderzoek. De volgende vraag wordt dus niet geïncludeerd in de studie.

Zou u hieronder uw telefoonnummer kunnen achterlaten? Mochten er op de dag van het interview onverwachts problemen op treden, dan kunnen wij u op tijd bereiken.

____

Dit was de laatste vraag. Als u klaar bent met de enquête, klik dan op 'verzenden'. Uw antwoorden worden dan verzonden.

Appendix 3.3 Physiotherapist survey - after using the WN program

VR ervaring na de sessie

U mag hieronder uw nummer invullen. Deze heeft u per mail toegezonden gekregen.

____

U krijgt nu enkele stellingen te zien. Deze stellingen gaan over hoe aanwezig u zich voelde in de virtuele omgeving. Deze stellingen mag u beantwoorden op een schaal van 1 tot 7.

Beantwoord de volgende stelling

	1 (helemaal niet)	2	3	4 (neutraal)	5	6	7 (heel erg)
Ik had het gevoel aanwezig te zijn in de computerwereld	○	○	○	○	○	○	○

Beantwoord de volgende stelling

	1 (helemaal oneens)	2	3	4 (neutraal)	5	6	7 (helemaal mee eens)
Ik had het gevoel omgeven te zijn door de virtuele wereld	○	○	○	○	○	○	○

Beantwoord de volgende stelling

	1 (helemaal mee oneens)	2	3	4 (neutraal)	5	6	7 (helemaal mee eens)
Ik had het gevoel slechts plaatjes te aanschouwen	○	○	○	○	○	○	○

Beantwoord de volgende stelling

	1 (helemaal mee oneens)	2	3	4 (neutraal)	5	6	7 (helemaal mee eens)
Ik had niet het gevoel in de virtuele ruimte aanwezig te zijn	○	○	○	○	○	○	○

Beantwoord de volgende stelling

	1 (helemaal mee oneens)	2	3	4 (neutraal)	5	6	7 (helemaal mee eens)
Ik had meer het gevoel bezig te zijn in de virtuele ruimte, dan dat ik het gevoel had iets van buitenaf te bedienen	○	○	○	○	○	○	○

Beantwoord de volgende stelling

	1 (helemaal mee oneens)	2	3	4 (neutraal)	5	6	7 (helemaal mee eens)
Ik voelde me aanwezig in de virtuele ruimte	○	○	○	○	○	○	○

Beantwoord de volgende vraag

	1 (zeer bewust)	2	3	4 (neutraal)	5	6	7 (helemaal niet bewust)
Hoe bewust was u zich van de echte omgeving (bijvoorbeeld geluiden van buiten, kamertemperatuur), terwijl u zich in de virtuele ruimte bevond?	○	○	○	○	○	○	○

Beantwoord de volgende stelling

	1 (helemaal mee oneens)	2	3	4 (neutraal)	5	6	7 (helemaal mee eens)
Ik was me niet bewust van mijn echte omgeving	○	○	○	○	○	○	○

Beantwoord de volgende stelling

	1 (helemaal mee oneens)	2	3	4 (neutraal)	5	6	7 (helemaal mee eens)
Ik lette nog op de echte omgeving	○	○	○	○	○	○	○

Beantwoord de volgende stelling

	1 (helemaal mee oneens)	2	3	4 (neutraal)	5	6	7 (helemaal mee eens)
Ik ging volledig op in de virtuele wereld	○	○	○	○	○	○	○

Beantwoord de volgende vraag

	1 (heel echt)	2	3	4 (neutraal)	5	6	7 (helemaal niet echt)
Hoe echt kwam de virtuele omgeving op u over?	○	○	○	○	○	○	○

Beantwoord de volgende vraag

	1 (geen overeenstemming)	2	3	4 (neutraal)	5	6	7 (volledige overenstemming)
In hoeverre kwam uw ervaring in de virtuele omgeving overeen met uw ervaringen in de echte wereld?	○	○	○	○	○	○	○

Beantwoord de volgende vraag

	1 (zoals een denkbeeldige wereld)	2	3	4 (neutraal)	5	6	7 (niet te onderscheiden van de echte wereld)
Hoe werkelijk kwam de virtuele wereld op u over?	○	○	○	○	○	○	○

Beantwoord de volgende stelling

	1 (helemaal mee oneens)	2	3	4 (neutraal)	5	6	7 (helemaal mee eens)
De virtuele wereld kwam echter op mij over dan de werkelijke wereld	○	○	○	○	○	○	○

Wilt u deze 10 stellingen beantwoorden?

	Zeer mee oneens	Oneens	Neutraal	Eens	Zeer mee eens
Ik denk dat ik dit systeem vaak zou willen gebruiken	○	○	○	○	○
Ik vond het systeem onnodig complex	○	○	○	○	○
Ik vond het systeem makkelijk om te gebruiken	○	○	○	○	○
Ik denk dat ik de hulp van een technisch persoon nodig heb om dit systeem te kunnen gebruiken	○	○	○	○	○
Ik vond dat de verschillende functies in het systeem goed geïntegreerd waren	○	○	○	○	○
Ik vond dat er te veel inconsistenties in dit systeem zaten	○	○	○	○	○
Ik kan me voorstellen dat de meeste fysiotherapeuten dit systeem snel zouden leren gebruiken	○	○	○	○	○
Ik vond het systeem erg omslachtig in het gebruik	○	○	○	○	○
Ik voelde me erg zelfverzekerd in het gebruik van het systeem	○	○	○	○	○
Ik moest veel dingen leren voordat ik met dit systeem aan de slag kon gaan	○	○	○	○	○

Dit was het einde van de vragenlijst. Wilt u uw antwoorden nog controleren, dan mag u op 'terug' klikken. Als u op 'verder' klikt, wordt de vragenlijst afgesloten. U kunt uw antwoorden dan niet meer aanpassen. Bent u bereid om nogmaals deel te nemen aan vervolgonderzoek over dit onderwerp? Laat dan alstublieft hieronder uw mailadres achter.

____

Appendix 4. Adapted definitions

4.1 Definitions and adapted definitions for the UTAUT.

***Table 2**. Domains of the UTAUT [82] and adapted definitions for this study*

Domain	Original definition	Definition for this study
Performance Expectancy	The degree to which the technology provides the individual with benefits	The degree to which the patient perceives that using VR as exercise therapy has benefits
Effort Expectancy	The degree of ease associated with using the technology	The degree to which the patient expects that learning how to use VR is easy
Social Influence	The extent to which the opinion of others influences the individual's intention to use the technology	The degree to which the patient believes that others' opinions will influence their intention.
Facilitating Conditions	The degree to which the individual believes that a technical infrastructure exists to support the use of the technology	The degree to which the patient believes that a technical infrastructure is available to support the use of VR.
Behavioural Intention	An individual's perceived likelihood of using a technology	The degree to which the patient beliefs he would use VR as exercise therapy, now or in the future.

4.2 Definitions and adapted definitions for the domains of the NASSS framework

***Table 3**. Definitions of the NASSS domains [68] and adapted definitions for this study*

Domain	Definition	Definition for this study
Condition	The characteristics of the health condition	The characteristics and complexities of axSpA
Technology	The features of the technological innovation	The applicability of the WN program towards axSpA patients and physiotherapists
Adopter system	The extend to which the technology is ready for its intended users	The extend to which the current WN program is ready for use among physiotherapists and axSpA patients
Organisation	The extend to which the technology fits with the organisation	The extend to which the current WN program fits within the physiotherapy setting

Appendix 5. Interview scheme

5.1 Interview scheme physiotherapists

Interview schema fysiotherapeuten

INTRODUCTIE

Allereerst wil ik u bedanken dat u wilt meenemen aan dit interview. Uw perspectief helpt ons om een duidelijker beeld te krijgen van de haalbaarheid van dit programma als oefentherapie.

Ik zal kort wat over mezelf vertellen. Ik ben Marieke Weenink, masterstudent Gezondheidswetenschappen aan de Universiteit van Twente. Via dit onderzoek zouden we graag meer te weten willen komen over de haalbaarheid van het Walk in Nature programma als oefentherapie voor patiënten met een vorm van reuma, axiale spondylartritis.

Dit interview zal naar verwachting 45 minuten duren. De antwoorden zullen worden opgenomen met deze voice-recorder. Deze opnames zullen puur voor het onderzoek worden gebruikt, en vertrouwelijke data die eventueel worden opgenomen, worden niet meegenomen in de verwerking van het onderzoek.

Het is belangrijk om te vermelden dat er geen juiste of verkeerde antwoorden zijn, ik ben vooral geïnteresseerd in uw perspectief over het onderwerp. Daarom wil ik benadrukken dat u u vrij mag voelen om alles te zeggen wat in u opkomt, en als u liever iets niet wilt bespreken, mag u dat ook altijd aangeven. Ten slotte, als wilt stoppen met het interview, mag u dat altijd aangeven. U hoeft hiervoor geen reden te geven. Heeft u verder nog vragen?

Dan gaan we beginnen en start ik de opname

START AUDIO OPNAME

Zou u kort wat over uzelf kunnen vertellen? Wat voor werk doet u?

Oké. Als het goed is heeft u van mij de informatiebrief ontvangen over het WN programma. Het doel hiervan was om een beter beeld te geven van wat het programma inhoudt. Tijdens dit interview zullen wij verder ingaan op dit programma, en de kansen voor uw en de doelgroep.

<u>De VR ervaring</u>

Goed, allereerst ben ik benieuwd wat uw ervaring was toen u de VR-bril ophad net. Kunt u daar wat over vertellen?

- Wat viel u positief op?
- Wat viel u negatief op?

Hoe gemakkelijk vond u om het programma te doorlopen toen u de bril op had?
Wat vond u van het klaarzetten van het programma? Vond u dat gemakkelijk, of zag u uitdagingen?

<u>De aandoening</u>

In hoeverre bent u bekend met de ziekte axSpa?

- Komt u de ziekte vaak tegen?
- Hoe ervaren patiënten hun ziekte volgens u?

Hoe ziet de behandeling van axSpA eruit?

- Wat is daarin uw rol als fysiotherapeut?
- In hoeverre zijn patiënten actief in het beheren van hun ziekte?

In hoeverre heeft u inzicht in het ziekte patroon van patiënten tussen afspraken door? Bijvoorbeeld: klachten, verergeringen of juist betere periodes

- Hoe ervaart u de communicatie met patiënten over hun aandoening? Hoe belangrijk is dit?

<u>De technologie en zijn potentiële gebruikers</u>

Heeft u VR wel eens gebruikt in uw praktijk?

- Wat was hierin uw ervaring?

In hoeverre denkt u dat deze doelgroep technologie inzet om hun ziekte te managen?

- Merkt u dat er vraag is naar technologie in de doelgroep?
- Heeft u wel eens een technologie ingezet bij deze doelgroep?

In hoeverre denkt u dat technologie toegankelijk is voor deze doelgroep?

- Zijn er bepaalde factoren die u terugziet in deze patiëntengroep, die het aanbieden van technologie kunnen belemmeren? Bijvoorbeeld: SES/ health literacy / technological skills

U heeft het programma even kunnen uitproberen. Welke waarde denkt u dat dit programma kan leveren voor patiënten?

- Wat vindt u positief aan het programma, kijkend naar de doelgroep?
- Welke behoeften ziet u vanuit de doelgroep veelal?
- Hoe past het programma binnen deze behoeften?

Hoe kan het programma zijn waarde aan patiënten vergroten?

- Wat vindt u bijvoorbeeld minder aan het programma als u rekening houdt met de doelgroep?
- Welke aanpassingen zijn nodig om het programma beter te laten passen bij wensen?

In hoeverre denkt u dat patiënten dit programma zullen gebruiken als het beschikbaar is?

- Wat is hierin uw rol?

Welke waarde denkt u dat dit programma kan leveren voor uzelf en u collega's?

- Hoe kan het programma zijn waarde aan u en uw collega's vergroten?
- Verwacht u dat er barrières zijn voor u of uw collega's om dit programma te gebruiken?

<u>De organisatie</u>

In hoeverre denkt u dat de huidige opzet geschikt voor gebruik in uw praktijk?

- Welke voordelen ziet u bij het gebruiken van dit programma in uw praktijk?
- Welke nadelen ziet u bij het gebruiken van dit programma in uw praktijk?
- Welke aanpassingen zijn nodig in het programma om beschikbaarheid voor de fysio praktijk te vergroten?

In hoeverre denkt u dat het gebruiken van dit programma aanpassingen vergt in uw <u>werk</u>?

- Zou u er bijvoorbeeld extra taken bij krijgen?

In hoeverre denkt u dat er in uw <u>praktijk</u> veranderingen nodig zijn om dit programma te kunnen gebruiken?

- Ruimte, Integratie met systemen, …

Ziet u potentie in het gebruik van het programma op een andere locatie dan thuis of de praktijk?

- Zo ja, welke? En hoe ziet u dan uw eigen rol terug?

Wat heeft u nodig aan ondersteuning om met dit programma te leren werken?

- Middelen, tijd, ruimte, ondersteuning van anderen om de technologie te leren kennen, etc.

Wat zou u overtuigen om het programma te gaan gebruiken?

- Heeft u bepaalde vereisten of informatie nodig om met dit programma te willen werken?

Heeft uw organisatie wel eens eerder innovaties doorgevoerd?

- Bent u hierbij betrokken geweest? Zo ja, wat was uw ervaring?
- Zijn er bepaalde hoofdpersonen die hierbij betrokken zijn vanuit uw praktijk?

In hoeverre denkt u dat de organisatie klaar is voor dit programma?

- Ziet u een goede match tussen dit programma en zijn doelen, en de missie van uw praktijk?
- In hoeverre voelen u en collega's zich aangemoedigd door management om innovaties uit te proberen?
- In hoeverre voelt u zich aangemoedigd door collega's om innovaties uit te proberen?

<u>Overige vragen - PSD</u>

In de vorige pilot vonden patiënten het programma complex. Hoe kan de complexiteit van het programma worden verminderd?

- Hoe kan het programma toegankelijker worden voor de doelgroep?

Bent u bekend met technologieën die thuis worden gebruikt door patiënten?

- Kunt u voorbeelden noemen?
- Wat zijn hierin de meest voorkomende functies?
- Zou u zulke functies ook willen terug zien in het programma?

We hadden het aan het begin al even over de ziekte inzicht van patiënten. Zou u meer inzicht willen in de ziekte van patiënten tussen afspraken door?

- Wat vindt u belangrijk om te weten? Bijvoorbeeld: inzicht in symptomen
- Welke aanpassingen zijn nodig in het programma om hiervoor te zorgen?

Denkt u dat het programma een rol kunnen spelen binnen de samenwerking met uw patiënt?

- Bijvoorbeeld: via een dashboard?

Welke strategieën gebruikt u om patiënten te motiveren?

- In hoeverre denkt u dat dit kan terugkomen in het programma?

In hoeverre denkt u dat het programma het oefenen leuker kan maken?

- Zijn er aanpassingen nodig om het programma leuker te maken? Bijvoorbeeld: de gaming elementen

In hoeverre denkt u dat patiënten vaker zullen oefenen met het programma?

- Zijn er aanpassingen nodig om dit te faciliteren? Bijvoorbeeld: aanpasbare oefeningen

Hoe betrouwbaar vindt u het programma op het moment

- Hoe kan de betrouwbaarheid van het programma worden verbeterd?

Hoe belangrijk denkt u dat sociale steun voor de doelgroep is?
Denkt u dat een sociale functie ook in het programma moet worden verwerkt?

- Zo ja, wat?

Oké, dit was de laatste vraag van het interview. Heeft u zelf nog vragen of opmerkingen die u wilt delen?
Dan stop ik nu de recorder. Heel erg bedankt voor uw tijd en deelname aan dit interview.

STOP AUDIO OPNAME

Appendix 6. Coding schemes

6.1 Patients - coding scheme

Interested in using VR				
Code	***Definition***	***Frequency***[a]	***Patients***[b]	***Quote***
Disrupt boring routines	Patients thought VR could break tedious routines	9	9	*“I think VR can break tedious exercises.” [75]*
Interesting	Patients found the idea of VR interesting	6	6	*“I can do these exercises on my own. I don’t need VR goggles for that.” [44]*
[a]: number of times the code was mentioned, b: number of patients that mentioned the code				

Not interested in using VR				
Code	***Definition***	***Frequency***	***Patients***	***Quote***
No added value	Patients saw no added value to current exercise routines	6	6	*“I can do these exercises on my own. I don’t need VR goggles for that.” [44]*
Suitability to their condition	Patients wondered whether the program would be suitable to their needs	5	5	*“I doubt whether the program is possible when you are bound to a wheelchair.” [82]*
Social aspect is important	Patients valued the social aspect of exercising	3	3	*"I prefer to exercise in the real world with real people around me." [18]*

VR at home				
Code	***Definition***	***Frequency***	***Patients***	***Quote***
Flexibility	Patients largely valued the flexibility that home use offers	14	14	*“Then I can practice in my own time” [63]*

Comfortability	The home setting is seen as most comfortable among several patients	8	8	*"I feel more comfortable at home" [190]*

VR at the physiotherapy practice				
Code	***Definition***	***Frequency***	***Patients***	***Quote***
Physical guidance	Patients prefer to have physical guidance with using the program	11	11	*"I prefer to do this under guidance at the physio" [24]*
Commitment	The physiotherapy practice feels more of a commitment to patients	9	9	*"Then there is more of an incentive to exercise." [138]*
Opportunity to practice	The physiotherapy practice is seen as an opportunity to practice with the program	6	6	*"I think I need some guidance first, then I can practice at home." [107]*

Useful exercises				
Code	***Definition***	***Frequency***	***Patients***	***Quote***
Stretching possibilities	Patients appreciate the stretching abilities	9	9	*"Stretching exercises like this yoga would be great for me" [67]*
Demonstration by the coach	The physiotherapy practice feels more of a commitment to patients	6	6	*"To be able to exercise, it is convenient that they are demonstrated in advance." – [122]*

Less useful exercises				
Code	***Definition***	***Frequency***	***Patients***	***Quote***
Not applicable	Some exercises were not applicable according to some patients	8	8	*"I don't need breathing exercises. I only do exercises to remain my mobility."]165]*
Similar exercises	Patients already perform similar exercises without VR	6	6	*"I already do yoga" [31]*
Not clear what it entails	To some patients, some exercises were not clear	3	3	"I don't know how the breathing would work with VR." [71]

Useful potential functions				
Code	***Definition***	***Frequency***	***Patients***	***Quote***
Performance quality	Feedback helps to perform exercises more correctly	8	8	*"If it [VR] can tell me how I should do my exercises then I'm all for it." [12]*
Fit with changing symptoms	Customizable levels help with patients' changing symptoms	5	5	: *"Every day I need to check what my symptoms are. If this can help with that, I'm all for it." [164]*

Less useful potential functions				
Code	***Definition***	***Frequency***	***Patients***	***Quote***
Help desk has no added value towards exercising	The help desk does not directly help to exercise	3	3	"*Maybe the helpdesk helps for questions, but I don't see direct value for exercising." [140]*

6.2 Physiotherapists - coding scheme

Positive about the program				
Code	***Definition***	***Frequency***[a]	***Therapists***[c]	***Quotes***
Comfortable headset	The headset was generally perceived as comfortable and easy to use	10	10	"I really like the headset, it was very comfortable and easy to put on." [6].
Good visual aspects	The program has good visual aspects and use of nature sounds	9	9	*"I like that I can completely look around here, and the bird sounds make me feel that I'm actually there" [5].*
Distract patients	The program may help to distract patients from their pain	9	8	*"I think it's nice that you are completely surrounded, you know, that might distract patients from their pain and prompt them to go move just a bit further. I really like that." [4].*
Increase enjoyment with exercising	Exercising may become more fun with the program	10	8	*"I think a VR program like this one definitely makes exercising more fun for patients." [3].*
Low VR induced symptoms	Physiotherapists perceived low VR-induced symptoms	9	7	*"I was a little dizzy, but I think that's because I've never used it before [VR]… And it would definitely not be an obstacle for me for a next time." [3]*
Variety in exercises	The program has good variety in exercises	9	7	*"It's nice that you've included all facets of exercises, so that it focusses on different aspects." [7].*
[a]: number of times the code was mentioned, c: number of therapists that mentioned the code				

Negatives about the program				
Code	***Definition***	***Frequency***	***Therapists***	***Quotes***
Inefficient in use	The program is currently perceived as inefficient	11	9	*"I like that I can completely look around here, and the bird sounds make me feel that I'm actually there" [5].*

Exercises are static	The exercises are not dynamic and may not fit with each patients' abilities	8	8	*"What I like about giving therapy, is that you can so easily adjust your exercises based on what the patient tells you. If he has more pain, let's make the exercises easier, if not, let's try to take it further That is not really possible now." [9].*
Difficult controllers	The controllers are difficult to use at first	9	8	*"I think a VR program like this one definitely makes exercising more fun for patients." [3]*.
High level of errors	The program's high level of error may detract from realistic experiences	9	7	*"I feel like, the current errors are too high for me to work with the program. Like some of these errors, they just make it seem less real, and in this program, you want it to look real. So that would lower my motivation to use the program overall." [143]* 2 therapists said that during the yoga exercise
Weight of the headset	The high weight of the headset might lower the experience of being in the environment	8	6	*"When I bent sideward, I felt the headset push in my face. That kind of got me out of the world, like, oh yeah, I'm doing exercises with a VR headset on, I'm not actually there. That was distracting." [4]*

Professional factors				
Code	***Definition***	***Frequency***	***Therapists***	***Quotes***
Training to operate the program	Physiotherapists need training to learn how to operate the program	10	10	*"We had to set them [VR headsets] up during each session, and that didn't go very smoothly at the beginning. That doesn't seem professional." [7]*
Time needed to increase own confidence	Physiotherapists expect to need time to increase their confidence with the program	10	8	*"Ultimately, you do need the time. Because, you know, I also need to understand thoroughly what these exercises are about. Later, when the patient comes to me with questions, I need to know the answers." [5].*
Time to practice with patients	Physiotherapists need enough time and space to introduce the program with patients	9	8	*"Perhaps you could first assess how far you can go for each exercise together. So, practicing, "Okay, I can touch this many butterflies before going too far; this yoga pose helps, but this one causes too much pain..." This way, you also keep yourself safe." [3].*
Type of training	Training preferences vary among physiotherapists	7	6	*"And you can try it out yourself and with colleagues to see what exactly that experience is like. That also means that you can explain it better to the patient, so to speak."[143]*

Personal technical support	Physiotherapists require technical support when they have questions about the program	6	4	*"If it[VR] doesn't work, then you feel like you've wasted half an hour of treatment for nothing. Colleagues are less enthusiastic to use it then, they skip it. You always need support for that." [4]*
Provide feedback on the program	Physiotherapists would like to be able to highlight areas of improvement when using the program	2	2	*"With previous ones [VR], I sometimes wanted to report that some functions were just not useful, or I felt like something was missing. But often, there is no place to do that. So, I would like to see that back. It makes you feel heard too, that it's not just about developing and throwing it on the market and be like "good luck"." [9].*

Organisational support				
Codes	***Definition***	***Frequency***	***Therapists***	***Quote***
Room without distractions	There should be an individual room available within the facility, where physiotherapists can guide patients who use the program	12	10	*"Yes, we have some space, but I can well imagine that three- or four-person practices have two treatment rooms and a coffee room. Then this is a lot less suitable" [6]*
Insight into costs	Therapists need a clear understanding of the costs associated with implementing and using the program.	12	9	"*However, when you buy one for the clinical setting, then I think more patients could use it, because therapists can share the headset and use it for all their patients combined." [4].*
Support from staff	Physiotherapists think support from management or colleagues will facilitate inmplemnetation	8	7	*"Yeah, I think that colleagues are very important in a way that VR can never reach on its own. It would be helpful if they back you up, let you know they believe in the project." [10]*
Reservation system	There should be a reservation system for who plans to reserve the program and when	6	5	*"And our practice is quite large, if they all want to use glasses, I think you should have some kind of written or online system for when someone uses them. And for what reason." [6]*
Cost-effectiveness	Before using the program, some therapists would like more insight into the program's cost-effectiveness	4	4	*"Yes, we also had a program like that, but it didn't fit on the laptop because it was actually very large, and we didn't have the good… yes, the good software for it, and that's why we couldn't do it. use immediately. That experience will linger when you sign up for new projects." [2*

Soft- and hardware considerations				
Codes	***Definition***	***Frequency***	***Therapists***	***Quote***
Insight into required equipment	Physiotherapists need more insight into hardware requirements for using the program within the practice, such as the headset, controllers, and additional equipment.	12	10	*"And if some patients cannot do yoga for that long, so these exercises are too difficult, then yes, you should also be able to sit on a chair. They can be done on a chair." [10]*
Software compatibility support	Therapists need support for the potential need of integrating the program with existing systems.	9	7	*"Yes, we also had such a program, but it didn't fit on the laptop because it was actually just too large, and we didn't have the right... well, the right software for it, and therefore we couldn't use it immediately." [3]*
Responsibility for equipment maintenance	There should be clear agreements on who is responsible for the equipment	5	5	*"And you also should consider maintenance. So, who checks from time to time whether these wires still work? What if one is broken? Or what if the program needs updates? Who arranges this? Is it the therapists' responsibility? That should be talked about too." [5]*
Potential necessary subscriptions	Managers should be aware of the potential costs of buying subscriptions for online accounts	4	3	*"I know we had an Oculus once, and there we were forced to create subscriptions, and that cost money. Also, half of the time we forgot what the password was. It was just a bit of a nuisance." [9]*
Necessary internet connections	Physiotherapists prefer to use the program without the necessary internet connections	3	2	*"I'm just thinking… what if the internet falls down? Will you still be able to use the program, or does it depend on Wi-Fi? That would make use more inconvenient." [2]*
Challenges of loaning equipment to patients	Physiotherapists should be aware of logistical challenges when lending VR equipment to patients	2	2	*"We no longer give the headsets to patients. No, because then another charging cord is lost... Is one broken, or did they do other things with it." [9]*

Guidelines for effective use				
Code	***Definition***	***Frequency***	***Therapists***	***Quote***

Clear protocol guielines	Physiotherapists would like more insight in when program can be used to guide patients in order to maximize therapeutic outcomes	7	7	*"It is nice that you know a little about what guidelines you have within such a treatment. And how you can best integrate that, things like that. Then you also know what you are using the program for." [5]*
Demonstrated effectiveness	The program's effectiveness should be demonstrated to positively influence physiotherapists' and patients' attitudes	6	6	*"It is beneficial for patients when the exercises are evidence based. Then they might be more open towards it. And for the physiotherapists as well, because I think that it [VR] will be used quicker then." [143].*
Applicability on axSpA symptoms	Physiotherapists want more insight in which axSpA symptoms the program can target	5	4	*"I still need to clearly define for myself what to focus on with a patient: is it the pain, or mobilization, or more breathing? Or can it be used to treat all symptoms at the same time? That I would like to know more about." [4]*

The need to improve usability for the physiotherapy practice				
Code	***Definition***	***Frequency***	***Therapists***	***Quote***
Lower the necessary equipment	The necessary materials should be lower	10	9	*"I think, when you use just the VR goggles, it would be easier to set up and I would be more inclined to use it." [3]*
Removing errors	The level of errors detracts from reliability	9	9	*"I would ensure that the program is free of errors and such because that tree wasn't working yet. Yeah, that does detract from the reliability." [2]*
Lengthy start-up time	The program should take less long to start up	7	6	*"You have like the Oculus app you need to check the equipment, the Unity app for the program, then in the Oculus environment the safety boundary you must draw… That is all a lot of software in which compatibility problems may arise." [9].*
Keep the ability to see what the patient sees	Therapists would like to see what the patient sees in the VR environment	5	5	*"I like how you can see what the patient is doing… You can really see where he's going, what he's doing, and give targeted instructions then." [8].*
Safety of the cable	The cable might lead to safety risks, but at the same time, most therapists will be there to monitor patients' movements	5	4	*"Patients could fall over the cable that is attached to the laptop" [7].*

No internet connections	The potential of no internet connections should be explored according to some therapists	3	2	*"I know this might be difficult to achieve, but maybe, somehow, you can go around the whole… need for an internet connection. I've faced some serious problems with that in the past." [3]*

Increase self-sufficient use				
Code	***Definition***	***Frequency***	***Therapists***	***Quote***
Practice round	The inclusion of practice rounds helps to rehearse exercises	10	10	*"When you wear the glasses, you cannot see which button is where. So, patients need to know that. Maybe with some kind of exercise where they have to use the buttons." [2]*
Clear navigation	The program should be more intuitive by providing clear navigation	10	9	*"Or we've also had modules in a previous VR headset, and each module meant a different task for patients to fulfil. But then they had more clarity on what was possible within the program. Maybe you can include this to within the program so that patients know what to expect." [9]*
Tutorial at the beginning of the program	The program should include a tutorial so patients can learn how the program works	8	8	*"Maybe you can give a tour through the program when patients first use it, so that they know what is possible within the program. That might help to lower the threshold to use it." [6]*
Inclusion of a helpdesk	A help desk may help to clarify patients' questions	6	5	*"And I think that some sort of help desk might help patients to use the program quicker, you know, so when their questions are answered, they can continue using it." [4]*
Only use goggles	Users should only have to use the goggles without additional materials	4	3	*"It might be a bit dangerous when you're walking around, trying to catch those butterflies… You don't know where the cable is." [6]*

Tailoring and monitoring				
Code	***Definition***	***Frequency***	***Therapists***	***Quote***
Customizable to patients' abilities and preferences	The program should have customizable levels to tailor to patients' abilities	10	10	*"Having a difficulty level within the exercise itself could be a solution, also to change it to the patient's level." [5]*
Self-tracking features	The inclusion of self-tracking features such as symptoms may help patients to manage their disease	9	8	*"When you see what the exercises can do to your symptoms, like, you see that exercising actually reduces your symptoms over time, you better understand what their relationship is." [6]*.

Challenges with self-tracking data	Self-tracking features may come with challenges such as privacy and obtrusiveness	4	4	*"They [axSpA patients] are not always that active in handling their disease, especially when there's not many symptoms yet." [2].*
Dashboard for physiotherapists	A dashboard helps therapists get insight into symptoms or usage behaviour	8	7	*"I often don't see patients for months, until they come back with flare-ups. And many struggle to describe how they experienced their symptoms, in the past months, you know... They just remember it has gotten worse." [8]*
Quality of movement	The program should include features that measure quality of movements	6	6	*"I find it very important that patients move correctly, especially with the yoga exercise as well. So, like, do you want to have a certain stretch somewhere? Then I think it's important that you stand properly and have a good form, and not create more problems for yourself." [9].*
Sensors that capture movement	Integrating sensors in the program may help to track movements and provide feedback to users	6	5	*"Sensors could probably detect that breathing movement, and then you can attach a score too that breathing, like the quality of breathing." [2].*

Importance of support				
Code	***Definition***	***Frequency***	***Therapists***	***Quote***
Gaming elements	Gaming elements may help to increase fun and motivation with the program	10	10	*"I believe people might be more motivated when there are gaming elements, like points or an award. Then it is acknowledged that they did something, and that is a big motivator I've seen." [5].*
Coaching	The program should include coaching to encourage patients	10	9	*"Patients sometimes tell me they have so many difficulties to do exercises on their own, but then at the practice, where they have our support and encouragement… I've been told that it makes a huge difference in terms of motivation." [10]*
Social features	Social features such as a multiplayer world may increase fun	5	4	*"I think it would be nice if you could do something together, for example exercise together like that yoga exercise. I think that is motivating. In some kind of multiplayer world, but I think that would be difficult to build in." [5]*
Education	Providing educational content may help patients understand their disease better	3	3	*"They [patients] often don't know how important exercising is, especially after being diagnosed. So ,education on this might help them manage their condition."[6]*

Appendix 7. PSD model

7.1 The four categories of the PSD model

Primary task support	Dialogue Support	Credibility Support	Social Support
Reduction	Praise	Trustworthiness	Social learning
Tunnelling	Rewards	Expertise	Social comparison
Tailoring	Reminders	Surface credibility	Normative influence
Personalization	Suggestion	Real-world feel	Social facilitation
Self-monitoring	Similarity	Authority	Cooperation
Simulation	Liking	Third-party endorsements	Competition
Rehearsal	Social role	Verifiability	Recognition