An HCI Perspective on Knee and Hip Condition Treatment: Interview Study with German Physiotherapists

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Abstract

We conducted six interviews with German physiotherapists in the context of current practices around knee and hip problems. Interview questions focused on medical conditions suitable for Human-Computer Interaction (HCI) studies, homework relevancy, individualization practices, and digital components used (or not used) in physiotherapy today. From these interviews, nine aspects relevant for HCI were synthesized, for example, that there is too little time in patients' appointments paid for by the health insurance companies, rendering homework exercises crucial for therapy success while patients' motivation is often lacking. Also, individualization matters as treatment strategies vary between physiotherapists and will be instantiated for the individual patient. The interview results confirm and extend related work in this context. For each result, we derived HCI-related implications that should be considered when support systems are conceptualized, developed, and evaluated.

CCS Concepts

• **Human-centered computing** → **Empirical studies in HCI**.

Keywords

HCI, Physiotherapy, Exercises, Homework Compliance, Individualization

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1 Introduction

"*Physical therapy is a common treatment that can help you recover after an injury or surgery, or manage symptoms from a health condition that affects how you move. It's a combination of exercises, stretches and movements that'll increase your strength, flexibility and mobility to help you move safely and more confidently*"[1]. While physiotherapy may traditionally be viewed as a clinical or medical domain, it is linked to the broader landscape of sports. Athletes – from elite professionals to recreational participants – can engage with physiotherapists not only for post-injury rehabilitation but also for, for example, preventative measures or performance optimization. As such, physiotherapy practices are relevant to the ongoing maintenance of athletic participation. According to a German study conducted a couple of years ago[2], physiotherapy was one of the most frequently utilized health service by Germans: this large-scale study (≈24.000 participants) found that every fifth person had physiotherapy treatment in the last twelve months.

Both perspectives underscore the relevancy of this domain and lead to the question how HCI interventions can support practices around physiotherapy – a question addressed in our current research project FedWell[3] focusing on common knee and hip conditions [2, 5][4] and their treatment in physiotherapy in Germany.

In this work, we present insights on current practices around physiotherapy, derived from an interview study with six German physiotherapists with expertise in rehabilitation of knee and hip problems. Interview questions focused on medical conditions suitable for HCI studies, homework relevancy, individualization practices, and digital components in physiotherapy today. We derived nine main interview results and associated implications that HCI practitioners should consider when conceptualizing, developing, and evaluating support systems for physiotherapists and patients.

2 Related Work

Individualized physiotherapy treatment plans are increasingly recognized as essential for optimizing patient outcomes [11]. Physiotherapists adapt interventions with the goal to enhance recovery trajectories and exercise adherence [12, 14]. Physiotherapists often emphasize aligning therapy with patient-specific goals, which enhances treatment compliance [3]. Rhodes and Fiala, for example, pinpoint that "*If clients can coordinate exercise time with the*

[1]Taken from https://my.clevelandclinic.org/health/treatments/physical-therapy, last accessed: 28.07.2025
[2]https://www.fitnessmarkt.de/magazin/artikel/studie-wer-nimmt-in-deutschland-physiotherapie-in-anspruch, last accessed: 28.07.2025
[3]https://www.dfki.de/web/forschung/projekte-publikationen/projekt/fedwell, last accessed: 28.07.2025
[4]See also https://www.gesundheitsatlas-deutschland.de/erkrankung/gonarthrose, last accessed: 28.07.2025

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affectively desirable properties of other activities, it should improve adherence outcomes" [14]. In the study by Bahns et al. [1], physiotherapists were interviewed, focusing on clinical practice guidelines implementation in Germany. They found that therapists highly value individualization of treatments. Their study also showed that physiotherapists are concerned that treatment may lose individuality when they strictly integrate clinical practice guidelines.

Homework exercises are a cornerstone of physiotherapy [16]. However, adherence to these is a known challenge [8]. Factors influencing poor adherence include, for example, lack of time or incompatibility of the exercise plans with daily routines, lack of motivation, lack of supervision and progress monitoring, and misunderstandings of exercise instructions [10, 16]. These findings emphasize the need for clear instruction, emphasis of the benefits of adhering to the exercise plan, motivational support and feedback, and possibly digital aids to enhance patient engagement and ensure consistent and effective rehabilitation outside the clinic as concluded by Sluijs et al. [16]: "*it seems highly relevant to investigate whether patient compliance can be facilitated by applying a number of compliance-enhancing strategies*".

Digital tools are increasingly being explored to enhance physiotherapy, though widespread adoption remains limited in Germany: for example, a 2025 national survey by Elser et al. [6] among 296 physiotherapists found that only 2.7% of them had used therapeutic virtual reality (VR), with the main reason for this low rate of application of VR being a lack of awareness. Similarly low rates (7%) have been reported, for example, from the Netherlands [15]. The study by Elser et al., however, also found significant interest in the future application of VR with 75% of therapists indicating that they can imagine using VR in the future [6].

Beyond VR, digital interventions such as telerehabilitation, mobile apps, telerobotics, and mixed reality are gaining recognition in musculoskeletal rehabilitation in Germany [18]. These tools can aim to enhance continuity of care, especially for at-home therapy and in regions with care shortages. Overall, among the main barriers limiting the adoption of digital technology in physiotherapy are lack of awareness [6, 15], professional resistance [9], lack of evidence, and missing interoperability [13]. In addition, studies highlight also that concerns regarding data security and insufficient financial reimbursement exist [7].

Previous work helped us in understanding common practices and barriers faced in physiotherapy. While some of the papers report recent findings and relate explicitly to our target domain [1, 6], these papers do not assume an HCI perspective and some of the previous works document problems and practices as they were implemented more than 20 years ago and in different countries [3, 10, 16]. To ground our future contributions in current physiotherapy practices in Germany and derive HCI-relevant insights, we conducted an interview study with German physiotherapists. This ensured our understanding reflects real-world conditions beyond the literature and focused on design-relevant aspects for future support systems.

3 Interview Study

We describe the conducted study, results and HCI implications.

3.1 Method

We wanted to confirm related work findings and gain insights into three topics:

1. What kind of knee and hip injuries are commonly treated in physiotherapy, how does the treatment process look like, and which aspects thereof are relevant to HCI?
2. Which role do homework exercises play? Does individualization matter and which factors are relevant for it?
3. What kind of (digital) components are already involved in the therapy and what would physiotherapists like to involve, but cannot currently?

Per topic, interview questions were derived and iterated within the project team (having a background in HCI and artificial intelligence (AI)). See Appendix A for an overview of the major questions asked. We decided on a semi-structured interview format as we expected that for some answers, the freedom of asking follow-up questions would lead to more insights

Six participants that are or were active physiotherapists in Germany were recruited for the interview. Table 1 gives an overview. All interviews were conducted remotely via Microsoft Teams. Only the audio was recorded. After each interview, participants could voluntarily fill out an online survey on demographic data (following [17]) and their experience with knee and hip patients. Participants were compensated with a 60€ Amazon voucher. Participation took 90 to 120 minutes. Audio files were transcribed and thematically analyzed [4]. To this end, two authors did a first pass through some of the transcripts separately and created code books, which were merged and refined through discussion. With the resulting code book, both authors then coded every transcript independently and results were compared. Deviations were solved by discussion. The study was approved by the ethical review board of the faculty of Mathematics and Computer Science at Saarland University (ID: 23-12-6).

3.2 Results

We will first present interview results (abbreviated with IR). For each IR, we derived an HCI implication.

IR1. Knee and hip issues are commonly treated in physiotherapy: In five interviews it was emphasized that knee/hip issues are a common problem: "*Assuming 16 patients [per day], there are certainly twelve knee or hip patients*"[5] (P4); "*daily*" (P6; reminder: P4 and P6, both working in a practice) or "*7-10 knees/hip patients per week*" (P3; reminder: working in an acute hospital). Frequently mentioned conditions were arthrosis, cruciate ligament rupture, and meniscus damage, representing a mixture of accident-related and longterm-related issues.

A potential risk in HCI studies with patients in general, especially if done unsupervised (what might be necessary, see **IR4/IR5**), could be problems due to patients overexerting or using prototypes incorrectly, risking relapses. Therefore, we asked which medical conditions would be suitable to focus on in HCI studies to minimize such risks. As a result, each of the conditions named above was

[5] Quotes were translated from German to English.

Table 1: Overview of participants. Q1 and Q2 are questions asked on a 5-point scale ranging from disagree (1) to agree (5): Q1: I would describe myself as technically savvy; Q2: I am open to technical innovations. Content in the interview column was mentioned during the interview characterizing the participant further. "n.p" means "answer not provided".

ID	Gender	Age	Experience	Q1	Q2	Interview
1	n.p.	n.p.	n.p.	n.p.	n.p.	16 years experience. Self-employed with own practice, worked many years in a hospital
2	woman	25–31	>6 years, but <12 years	3	5	Works in a practice. At the moment different focus, but worked with hip patients in the past. Has also a background in osteopathy
3	man	25–31	>6 years, but <12 years	4	5	Worked for a long time in rehabilitation clinics, now in an acute hospital
4	woman	25–31	>3 years, but <6 years	3	5	Works in a practice
5	woman	25–31	>12 years, but <18 years	2	3	Self-employed osteopath with own practice; trained physiotherapist
6	man	25–31	>12 years, but <18 years	4	5	Self-employed with large own practice. Lecturer for physiotherapy

mentioned twice by interviewees as being suitable – yet only if a couple of weeks have passed after a potential surgery.

HCI Implication 1: Knee and hip conditions offer promising use cases for HCI interventions

Knee and hip conditions seem reasonable for HCI interventions as they are common, opening up large participant pools. Moreover, risks implied by HCI studies are rather low if interventions are not directly applied after a surgery. Systems, techniques, or prototypes tested in such studies, however, should be checked first by experts to identify potential risks involved when used by knee/hip patients to avoid negative impacts on recovery trajectories.

IR2. Individual treatments are more relevant: All experts stated that for knee/hip issues, the primary treatment is individual work with the physiotherapist, while group therapy primarily occurs after surgeries in rehabilitation clinics or much later in the process. Concerning physiotherapist-patient relationships, it is logistically not always possible (mainly depending on the size of the practice) that the same physiotherapist will perform the treatment.

HCI Implication 2: HCI interventions for individual patients and groups of patients are possible

Scenarios where only one patient is present makes executing HCI-related studies easier (e.g., ease of recruiting, less coordination effort, no bias through group dynamics). Yet also systems focusing on group interventions can find usage in current practices, especially if rehabilitation clinics are involved. Varying therapists lead to demands in respect to proper hand-overs and can lead to challenges in terms of alignment of individualized treatment approaches, as mentioned by Bahns et al. [1].

IR3. Time is an issue for physiotherapists: Five physiotherapists told us that the time during appointments for knee-hip issues is too low (between 20–25 minutes). In addition, also the number of appointments paid for by health insurance was deemed too low (mentioned 3x): for knee/hip conditions, each prescription by doctors covers six appointments and it appears that up to three are uncomplicated to obtain. The first appointment is primarily allocated for the anamnesis. Some participants also told us that they distribute appointment slots over several weeks (although prescriptions would allow for two or three per week), with the goal to work with the patient over a longer time for achieving better results. That limited time is a general issue was stated by five therapists, often in the context of questions where we discussed potential for technological additions:"*Unfortunately we don't have the time*" (P1) or "*There's not enough time for that. It can't be integrated into the daily work routine*" (P2). P2 also told us that certain tasks are already done in her spare time (e.g., writing special reports for patients).

HCI Implication 3: Support systems must align with the limited time available to physiotherapists

As time is a scarce resource, support systems should not require additional time invest from the physiotherapists: systems have to tightly integrate with existing workflows and should increase the time spent working with the patient. If new systems require more time invest in one area, they have to save time in another area (e.g., mandatory documentation steps becoming easier when the patient or system documents how often and how correctly they perform exercises at home) – else, such systems would likely not be accepted. The frequency of patient and physiotherapist meetings is a tradeoff they have to decide on (i.e., seeing the patient more often in a week allows for more fine-grained checks but ends the therapy earlier overall). This has to be considered if the physiotherapist's input is necessary for the support system.

IR4. Doing exercises at home is important for therapy success: Given **IR3**, all experts stated that homework exercises are integral to the treatment process, as exemplified by P1: "*You can really see the significant difference between patients who do something and patients who do nothing.*". Physiotherapists have diverse approaches to homework. Patients' necessary time invest remains manageable and ranges from five to 25 minutes on average (and up to 45 minutes at later therapy stages according to P4). Therapists change homework over time, sometimes from week to week. The

highest number of exercises mentioned was ten. The most often mentioned assigned execution frequency was daily (5x) with one person stating that exercises should even be repeated two or three times a day. Two physiotherapists stated to select exercises with a lower complexity to ease correct execution without supervision. All therapists mentioned that incorrect execution is less problematic when not performed over longer time frames, as it only affects exercise efficiency: "*Yes, of course there is a wrong somewhere. Somewhere if you are grossly negligent, but the wrong thing to do would be to do nothing at all*" (P1). Teaching exercises involves verbal explanations and demonstrations (5x) and letting patients perform the exercise under supervision during appointments (5x). Three reported to write exercise steps down, scribble them (2x), or print something out (3x) for patients to remember. On a voluntary basis, physiotherapists also offered recording videos of the exercise (with the patient's smartphone) (6x) and asynchronous (e.g., via messenger) or synchronous support (e.g., via phone call) for patients exercising at home (3x). The physiotherapists typically ask patients how the execution of a new homework exercise went in a follow-up appointment (4x). All stated that they request some repetitions during the appointment: not remembering would be an indication that patients did not exercise at home. In general, it was emphasized (3x) that for experts, a visual check is sufficient to assess exercise execution correctness. We asked if they would be interested in knowing whether patients did their homework in the assigned frequency, which all experts agreed to. Yet, reasons for this varied. P1, for example, stated that this kind of control might be motivational for the patients, while P3 stated that if a patient is compliant, but shows no improvements in the healing process, it would allow him to switch the therapy approach. In addition, four physiotherapists would like to know whether the homework exercises have been executed correctly.

HCI Implication 4: HCI interventions can support patients performing physiotherapy exercises at home

Support systems reminding patients to exercise in the assigned frequency and teaching them how to exercise correctly are important, and tracking (in)correct executions would be beneficial for both parties: Patients could receive feedback and physiotherapist could gain insights (given a proper user interface) on the patient's performance since the last appointment, even allowing to skip additional control steps – leaving more time to actively work with the patient. Such systems could be useful for documentation purposes and would give arguments towards doctors and health insurance for prolonging the therapy when the patient's full compliance can be proven. A technological challenge will be to create usable and cost-efficient systems (see **IR9**) able to detect exercise executions at home. Likely, these systems have to work with equipment that the patient already owns, such as a smartphone. Given that experts do a visual check for correctness, camera-based approaches might be feasible. Systems that only work with the patient's manual confirmation of completed exercise might be prone to cheating.

IR5: Patients often lack motivation to do homework exercises: Four physiotherapists mentioned that the motivation of patients to do homework exercises is often low. A complementary theme was that patients apparently forget to do the exercises or how to execute some of them (4x), and are afraid of doing them incorrectly in such cases (1x). Five physiotherapists also talked about the patients' lack of knowledge (and two even about lack of interest), demanding better information and education opportunities to allow patients to understand their own health issues, which might be helpful for compliance.

HCI Implication 5: Educational and motivational systems are beneficial

Educative systems are important to clarify the relevancy of homework exercise and motivational systems can support compliance. Both layers can be built on top of technology that is able to track exercise executions automatically (see implication before). If a system could also explain why an execution is incorrect and provide guidance similarly to what a physiotherapist would do, the fear of exercising incorrectly could be reduced. Motivational systems should have strategies to convince a patient to start with their exercises, but also to re-do them in the proper frequency. Ideally, if a motivational system can detect that a user is unlikely to complete all exercises, which could demotivate the patient to start exercising at all, the system could adapt (see **IR7**) the exercise plan by reducing the number of exercises (following the second quote in **IR4**).

IR6. Physiotherapists have different approaches: Five physiotherapists stated that their individual treatment approaches for different knee/hip conditions is similar, but will be adjusted based on individual patient factors (see **IR7**). Treatment approaches vary across physiotherapists (mentioned 4x): "*Every therapist cooks their own soup*" (P2) and "*Training courses for physiotherapists are not standardized in Germany*" (P6). All experts told us that neither exercises nor naming schemes are largely standardized in literature, and some are even protected and require licensing to use them. Physiotherapy can happen before and/or after a surgery. While physiotherapy after a surgery serves rehabilitation, physiotherapy before a surgery has the goal to postpone the surgery for as long as possible, even up to the point that it is not necessary anymore.

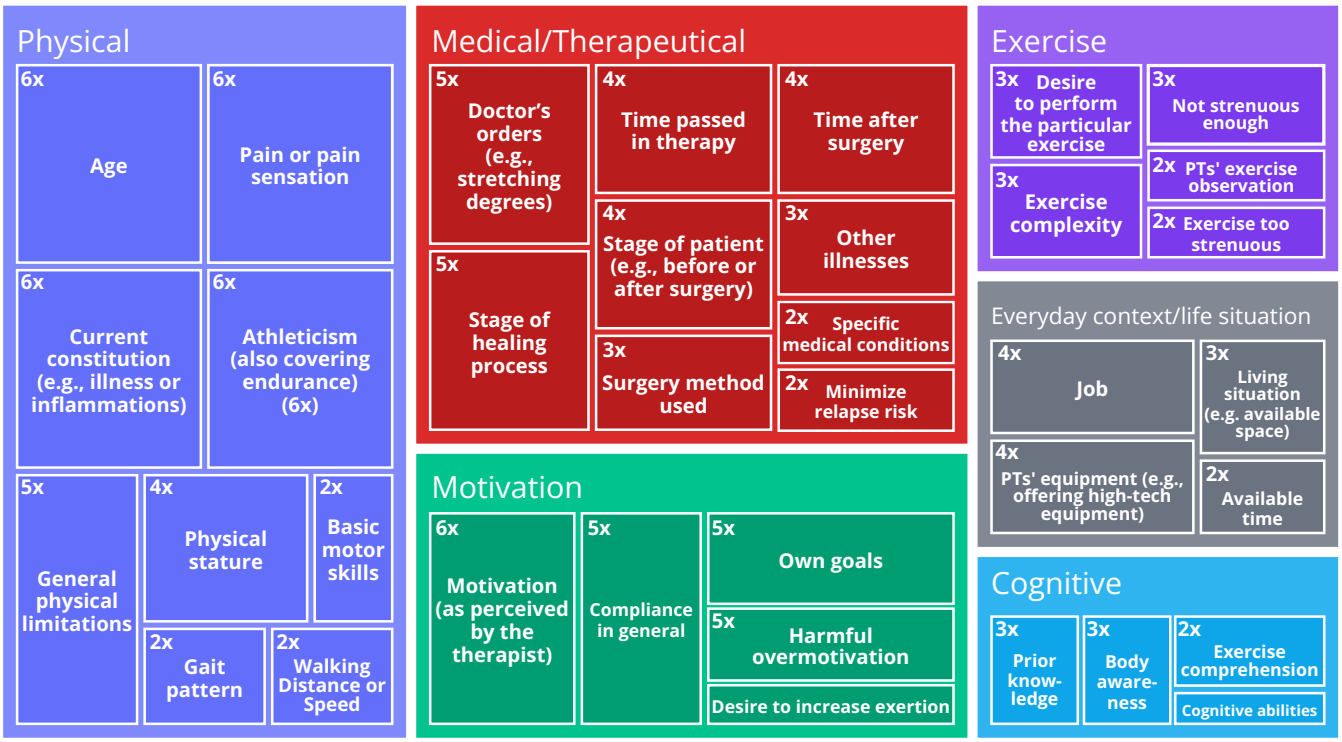

Figure 1: Factors that experts consider for deciding for exercises or adaptions of these. If not denoted otherwise, factors always relate to the patient (e.g., "available time" means "patient's available time"). Number in upper left corner indicates how often the factor was mentioned in the interviews. No indication here, means "1x" and PT stands for physiotherapist.

HCI Implication 6: Physiotherapists need customizable systems

Systems have to be adaptable/adaptive to complement the physiotherapist's chosen treatment approach. If exercises are part of this support system, search capabilities should account for the mentioned limitations. Furthermore, functions should allow physiotherapists to setup their own routines that they frequently use to save time (see **IR3**), especially covering different stages a patient might be in. Depending on the preferences of the therapist, systems could also inform about treatment approaches chosen by colleagues and, for example, suggest exercise programs that have proven to be successful in similar cases in the past.

IR7. Physiotherapists consider several factors for exercise selection and adjustment: A number of factors (see Figure 1) how physiotherapists decide for exercises and their parameters were mentioned. Numbers in the figure denote how often aspects were mentioned. A low number does not mean that others do not consider this factor, just that they did not talk about it during the interview. For readability reasons only, we clustered them into six categories. Please note that factors could also fit to more categories. Aspects that physiotherapists adjust based on these factors are listed in Table 2.

Table 2: Exercise plan adaptation options. Number in parenthesis indicates how many experts mentioned this aspect.

- Number of repetitions per set (6x)
- Adjusting the training load (e.g., involving (less/more) weight) (6x)
- Exercise alternative selection (e.g., if the movement for the originally planned exercise is not possible) (5x)
- Number of exercises (4x)
- Inclusion of objects (e.g., to modify the exercise difficulty level) (4x)
- Changing the training surface (e.g., hard or soft surface) (4x)
- Body position during execution (e.g, sitting vs. standing) (4x)
- Homework exercise frequency (e.g., more times per day) (4x)
- Feasibility for everyday use (i.e., possibility to execute during day-to-day activities) (3x)
- Optimization for everyday activities (e.g., exercises train movements that a patient needs in everyday life) (2x)
- Adjusting target positions (e.g., extent of muscle expansion in an exercise) (2x)
- Number of sets per exercise (2x)
- Adjusting break time between exercises (1x)
- Adjusting how long an exercise should be executed (1x)

HCI Implication 7: Adaptive systems are beneficial

Systems with personalization or customization components are reasonable for patients, as the homework exercises can be adapted between appointments. This is especially helpful if the time between appointments is longer (see **IR3**) to maximize training effect and/or increase the patient's motivation to exercise. A challenge yet is how to make the factors available for personalization engines. Figure 1, for example, covers factors that have to be provided by the patient and factors provided by the physiotherapist or doctor. Another dimension is whether factors have to be collected once (e.g., age via collecting the birth date), or continuously (e.g., current constitution). Given that physiotherapists indicated factors they currently use, the question is which factors could be of relevance if more data is made available: a exercise system that would know which kind of activities the patient engaged in today (e.g., completing a long walk), and that has semantic knowledge (e.g., the purpose of individual exercises) could meaningfully modify the plan to optimize for patient compliance and treatment outcome (e.g., by replacing exercises that target muscle groups already trained during everyday activities).

IR8. Home exercises: minimal space demands; often hands- and object-free: Exercises at home need only little free space (5x) and all stated that typically the hands are free in knee/hip exercises when not used for stabilization reasons. Most exercises do not require additional objects or special equipment. Yet, a couple of objects were mentioned that are used sometimes. Here, we can distinguish between everyday objects most people should have available at home (e.g., bottle (mentioned 2x), mirror (4x), table (1x), blanket (1x), wall (3x), chair (2x), staircase (2x), scale (2x)), specific training-related objects that can be bought (e.g., resistance band (4x), gym ball or normal balls (3x), weights (5x), mat (3x), foam cushions (2x)) and objects that are primarily used in the practice (e.g., infrared measuring device (1x), measuring tape (1x), trampoline (1x), ganiometer (4x), pressure sensor plates (1x), newton-metre (1x), balance board (1x), wearable sensors (3x), special lights (1x)).

HCI Implication 8: Leverage hands-free exercises

The mostly hands-free exercises allow to use additional devices and thus open up a design space for HCI solutions that could support knee/hip patients while exercising. Future work should consider how everyday objects and training-related equipment can be integrated into support systems as well. The usage of physical objects, for example, is known from the domains of tangible user interfaces, haptics, or VR, and might offer unique potential for immersive and engaging exercise support systems. HCI research needs to consider how adaptive systems could dynamically decide when and how object usage could be recommended, how they can be tracked (if necessary), or how they could be used to maximize patient motivation.

IR9. Digital tools and sensors are known, but not frequently used: Therapists mentioned physiotherapy apps that would benefit patients (e.g., Lanista[6], Tinana[7], PhysioTec[8]). Yet, only P6 actually planned to use one of them in the future. P1 and P6 mentioned sensors that they currently use: Orthelligent-Pro[9] (a band that can be attached to the knee and measures factors like range of motion and strength/speed), and Myoact[10] (for EMG measurements). In addition, special lights for reaction-based training are used by P6. Four physiotherapists stated that the associated costs for using digital tools/sensors is a limiting factor (e.g., "*... but for the small budget, which we often have, [it is] simply not sustainable*" (P1) or "*That's just not feasible for a small practice, you simply have to say that it's only possible on a larger scale, because we don't get paid for it*" (P6)). AIRIS[11] or special treadmills or bicycles with functions like running or cycling within virtual landscapes or other playful features (similar to systems like Zwift[12]) were named in the context of motivational systems, but again with their price being a limiting factor ("*Because it's also an additional module that can't be billed anywhere. And that is always an obstacle for many therapy practices. These treadmills in particular, which cost 100,000€, are great. But I can't bill for them. I don't get any money for it.*" (P6)). Besides the associated cost, however, also the time effort has to be accounted for: "*We have 20 minutes, if I then have to go through the time-consuming process of booting up some system, if I then have to use it permanently, it's already impractical for me. And in the best case, it's mobile*" (P6). Some features that they would find interesting in digital systems, which were mentioned at least twice, are: diary function for patients (5x), in which executed exercises are documented, together with feedback (e.g., pain levels) and other health-related aspects; a tool providing live exercise feedback (4x); showing exercise videos (3x); digital patient questionnaires that are automatically evaluated (2x); and receiving a quick overview how a patient performed since the last appointment, but also over time (2x).

HCI Implication 9: Financial resources are a limiting factor

Given that there are already a number of commercial systems, the result shows that the stakeholders do not have the financial power to use them – an aspect also mentioned by the participants in Elser et al.'s study [6]. This seems critical at least as long as the German healthcare system does not pay for such additional services and tools. HCI approaches should consider this factor and not require expensive instrumentation or software licenses to be useful. Accessibility, easy usage, and short setup times are other factors that such systems have to provide, similar to the feature requests.

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3.3 Discussion & Limitations

These results underline the current situation in Germany. Many findings are in line with results of related literature, even dating back more than 20 years, unveiling HCI issues and demands that still exist in this domain to date. The HCI implications derived in this paper are a fruitful starting point for discussions and should be considered for support systems that are created to be used in in-the-wild settings, leveraging this potential.

Focusing on German experts only is a limitation. However, this decision was a purposeful one with our project's focus and funding being specifically directed towards the German case. This might limit the generalizability of our results to other countries, especially depending on differences to their healthcare system. Yet still, we think that many of our findings will be applicable to other countries as well. Another limitation is the low number of physiotherapists that participated in this study. A higher number of participants might have led to more experts already using (other) digital systems, providing further insights into usage patterns. Given our confirmatory approach, however, the number seems sufficient, especially given the observable convergence of answers regarding many of the questions.

4 Outlook

Based on the related work, the results, and the derived implications, we intend to create a support system that focuses on the time between physiotherapist appointments: Similar to existing systems, physiotherapists can add anamnesis data in an easy fashion (e.g., via voice-input) and assign homework exercises (e.g., using presets and exercise catalogs). Both steps are part of their work routine already and the support functions would ideally reduce time invest for the therapists. Additionally, therapists could inspect how patients performed.

Patients see assigned homework via an app with additional information (e.g., videos). The difference to existing apps is that the homework would be dynamically adjusted leveraging AI-based methods, based on information in a user model, which might have access to data (if made available by the patient) either collected directly through the app itself (e.g., step data), by integrating external data sources (e.g., calender app), through data from the physiotherapist (e.g., anamnesis), and provided by the patients themselves explicitly (e.g., feedback on exercises) and implicitly (e.g., performance in exercise, potentially tracked via consumer hardware). Factors found in the interviews will guide the system development. Adaptations will have limits that an physiotherapist can set on a per-exercise level and that would not be exceeded. Within these limits, the system will be able to continuously modify the number of exercises, the type of exercises, and their intensity.

Implications might be an increased training effect or reduced demands to motivate patients. Our future user studies will investigate whether this approach is reasonable. Such a system could generalize beyond physiotherapy to other sports-related domains in which training plans are involved.

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A Interview Questions

We introduced participants to the FedWell project by explaining the major goals that we want to achieve within it (e.g., supporting rehabilitation through digital means, offering individualization options, integrating more sensor inputs, etc.) and that we focus on knee and hip patients. We followed up with a semi-structured interview format; the following list shows the major questions that we asked in every interview (translated from German to English):

- Can you start by telling me a little about your experience in the field of rehabilitation and physiotherapy?
- How much experience do you have with patients who have hip or knee problems?
- In your experience, how common are problems in the hip or knee area?
- How often do hip or knee problems result in surgery? How often can the problem be resolved without surgery? (*Note: multiple questions per bullet point were asked only after the first one had been answered*)
- In your experience, how different are the medical conditions that result in hip or knee surgery? Do the rehabilitation measures and physiotherapy treatment for these conditions differ?
- As we also want to conduct (HCI) studies with patients in the future, we are looking for medical conditions where the number of possible physiotherapeutic approaches is high on the one hand, but where the risk of making something worse for health (for example because a motivation system motivates someone to perform more exercise repetitions than recommended) is low on the other. It would also be important for us to be able to 'easily' recruit a larger number of test subjects, i.e., medical conditions that only occur rarely make this more difficult. Which conditions would you advise us to focus on from this point of view?
- Can you tell us more about this medical condition? Why is the health risk here low? How many patients suffer from it? Why are there different physiotherapeutic approaches? What role does surgery play here? Is it unavoidable? What is the typical rehabilitation process or physiotherapy treatment for this? (*Note: many of the subsequent questions should be answered by focusing on the medical condition mentioned here*)
- Which aspects relevant to the subsequent measures take place before a potential surgery? What condition are patients in a few days after a potential surgery?
- When does the rehabilitation/physiotherapy start? Does the type of therapy approach change over time (e.g., week 1 after surgery vs. week 4 after surgery)?
- Does the treatment consist of group and/or individual sessions?
- Do patients only perform exercises under your supervision, or are there also exercises that you are supposed to perform without supervision ('homework')? Can you say something about the scope of this 'homework'? In your opinion, how important is homework for this medical condition?
- Can you give us the names of some exercises that are typically performed for this medical condition? Is there a catalog of exercises or a specialist manual?
- Are objects used in these exercises? If yes, which ones and how? Do patients have their hands free during these exercises?
- How do you determine whether an exercise is being performed correctly? Are there simple indicators that laypeople can use (e.g., by observing in a mirror)? Which aspects are not easy for laypeople to understand?
- To what extent do you provide patients with knowledge about the underlying core problems (e.g., unhealthy movements of the knee) and what should be considered by patients in the future as prevention after treatment has been completed?
- Let us assume that you are treating two different patients who have the aforementioned medical condition: how do your treatments differ for these patients? On what basis do you decide the approaches?
- Do you also adapt the respective exercises during the course of treatment? In what way? How do you determine that an adjustment should be made? Can it happen that patients find the exercises too easy? What do you do then? Would you like to customize even more, but cannot? Why not?
- What scope for individualization is there in general for treatments, regardless of the medical condition? What factors or information do you use for this? Can you give us a few examples? Are there simple rules here ('if X, I don't do Y')?
- What are typical reasons (directly or indirectly) given by patients on which you adapt or individualize exercises?
- Can each exercise be replaced with an alternative exercise or are there exercises that must remain in the plan in the same way?
- How often are exercises or exercise parameters adapted? Could more frequent adjustments be beneficial?
- How do you deal with short-term patient problems?
- How do you explain exercises to patients that they will not be performing under your supervision at home?
- How do you ensure that patients perform them correctly on their own? Is there a health risk in patients performing exercises incorrectly at home multiple times?
- Do you already have measures in place if patients realize at home that they have forgotten how to perform an exercise? If so, which ones?
- Would you like to know whether the exercises shown have also been performed at home with the specified frequency/correctly?
- In your opinion, how often does it happen that 'homework' is not completed to the extent specified by you?
- How do you assess the risk of exercises being performed incorrectly at home? Are there any exercises that you would never give as homework because they are too prone to errors? Are there any exercises that you would only give as homework once you have been able to see for yourself that the movements have been performed correctly?
- Could you imagine reviewing video recordings of patients performing exercises at home afterwards? Could you imagine synchronized monitoring of exercises that patients perform at home?
- Do you already use technological solutions (e.g. smartphone apps) to interact with your patients? If yes, which ones and

what functions do they have? What are your experiences with them? What data is made available to you? Which of them are helpful? What data do you miss? If no, why not?

- Could you imagine if and how a digital support system could help you and patients in general?