

Factors for Individualization of Therapeutic Exercises for the Design of Health-Enabling Technologies

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Abstract. Designing health-enabling technologies (HETs) to support individualized physiotherapeutic exercises requires comprehensive knowledge of bio-psychosocial factors to be considered. Therefore, this review identified factors for individualization of therapeutic exercises in patients with musculoskeletal shoulder disorders in peer-reviewed articles searched in MEDLINE. The final full-text analysis included 16 of 335 search results and extracted nineteen main categories of individualization factors. The most frequently identified main categories include *progression of exercises*, *exercise framework*, and *assessment*. An iterative approach with constant reassessments represents the key principle for the process of individualization. Categories that are difficult to standardize were rarely mentioned, but should also be considered. The identified factors can improve the design-process of HETs by sensitizing developers, enable further formal modelling, and support communication between developers, physiotherapists, and patients.

Keywords. health-enabling technology, physical therapy, individualization, exercise

1. Introduction

Health-enabling technologies (HETs) are sensor-based information and communication technologies that promote a person's individual health, healthcare, and quality of life [1]. In physical therapy HETs can assist patients in performing exercises at home and support physiotherapists in assessments [2]. First studies indicate superiority of individualized compared to standardized non-individualized exercises in patients with musculoskeletal shoulder disorders [3]. HETs and treatment processes with HETs that assist patients and therapists with exercises should therefore promote individualized exercises and enable or support adaptation to the individual patient. Beyond this background, this literature review aimed to identify factors for individualization of therapeutic exercises in patients with musculoskeletal shoulder disorders to provide knowledge for designing HETs.

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2. Methods

The literature search and review process followed the PRISMA-ScR protocol [4]. Medical subject headings and text words related to the terms “upper extremity”, “exercise and physical therapy”, and “adaptation, progression, individualization, or personalization” constituted the search term in MEDLINE (via PubMed, on November 13, 2020). Two reviewers (LE and BSt) independently screened the 335 identified titles and abstracts against pre-defined inclusion and exclusion criteria. Reasons for exclusion were documented using the following main categories: 1. No focus on musculoskeletal shoulder disorders (n=184); 2. No exercise (n=24); 3. Exercises not individualized (n=82); 4. Other topics (e.g., prevalence of injuries during training) (n=13); 5. Language other than English or German (n=2). Full-text screening of the remaining 30 articles revealed five full-texts not reporting on individualized exercises. Nine full-texts were companion articles to the included main full-texts. The remaining 16 full-texts were incorporated in a systematic narrative synthesis based on a coding frame. The coding frame was built using a mix of concept- and data-driven-approaches [5] with some pre-defined main categories using the qualitative data analysis software MAXQDA (version 20.1.1; VERBI GmbH). The identified categories were illustrated in a code tree.

3. Results

Sixteen articles describing 15 projects were included [6-21]. One project was best represented by two complementing publications [19] and [20]. The 16 articles were published between 2007 and 2020. Treatment duration ranged from a single treatment to 5 months. Twelve weeks was the most common treatment period (n=6). Target group were patients with musculoskeletal shoulder disorders (e.g., subacromial impingement syndrome). The number of patients assessed ranged from one to 708 with a median of 90. Different study types were present ranging from the evaluation of a HET to case reports and qualitative interview studies to randomized controlled trials.

Different types of individualization were identified. Besides selecting, personalizing, and progressing exercises, creating exercises was mentioned as a type of individualization. However, a detailed description of the procedure for creating exercises was missing. Kromer et al. [17] reported to proceed in the sense of clinical reasoning and thus create exercises. Anton et al. [6] claimed that the interface of their HET supports the creation of new exercises, but did not elaborate or refer to expert knowledge.

The analysis yielded 19 main categories and 87 sub-categories for individualization of exercises. With 23 sub-categories occurring in 59 coded segments in 14 articles the *progression of exercises* was the most frequent main category. *Progression of exercises* was realized, for example, by *different performance levels* [10] with validated scales for perceived *exertion* or reported *pain* [14,15]. The second and the third most frequent main categories were *assessment* (34 coded segments, 10 articles) and *exercise framework* (22 coded segments, eight articles). *Validated assessment tools*, like the *Western Ontario Shoulder Index* [7], *range of motion* (ROM) [16], and *compliance measures* [7], were applied. Measurements, such as ROM, served both as decision criteria to decide whether a certain exercise can be started [7] and to evaluate whether an exercise is effective [6]. *Assessments* were performed with *re-tests* and thus served to adapt exercises to the patient both at the start of treatment and during the course of treatment [17,20,21]. The constant reassessment was inherent in the individualization process.

Factors maintaining or contributing to a patient's problem could be *leisure and sport activities* [20] or the *work place setting* [17]. In Anton et al. [6], the exercise individualization was based, among other things, on formalized knowledge in an ontology on biomechanical aspects. Figure 1 shows the main categories with frequency.

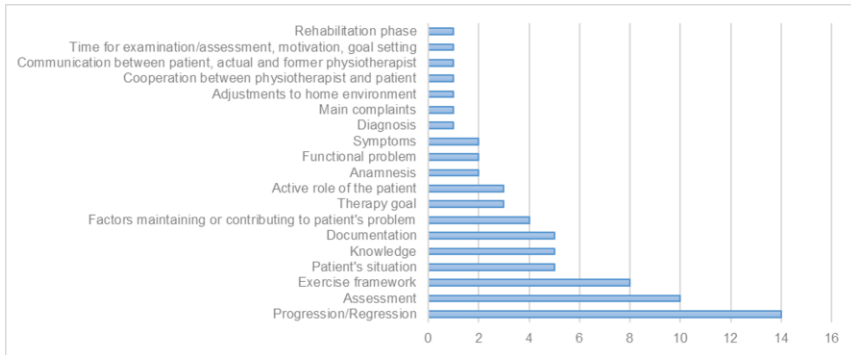


Figure 1. Main categories with frequency.

4. Discussion and Conclusions

Different individualization approaches of exercises are evident. Constant reassessment was identified as a key principle. Consequently, regardless of the selected approach, HETs should support or at least allow for reassessments. Since most rare individualization factors seem to be difficult to standardize, they may be underrepresented in this review of mostly highly standardized studies. However, that does not make them less important. Physiotherapy basically aims at sensomotoric self-determination of the individual and thus requires a meaningful frame of reference [22]. This means that exercises and therapy goals must be meaningful to the patient. Therefore, patients' everyday life, their environment, and their goals play a major role in the individualization of exercises. The rare as well as the frequent factors should be considered when designing HETs and physiotherapeutic treatment processes with HETs. Already in this limited literature search, the identified factors can provide insights, serve as a basis for further formal modeling and support the design-process of HETs. The results can sensitize developers and support communication between developers, physiotherapists, and patients. Further data collection and modelling, for example, in the form of an ontology, are planned to sufficiently support the design of HETs.

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