

Digital Movement Therapy for Axial Spondyloarthritis: A Randomized Controlled Trial on Clinical Outcomes, Usability, and Costs

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Research Article

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Abstract

Background:

Axial Spondyloarthritis (axSpAs) are inflammatory diseases of the spine that lead to significant stiffness and physical impairment. Digital health applications (DHAs), particularly those incorporating digital movement therapies (DMT), are increasingly popular for promoting physical activity. This study aimed to assess the impact of DMT using the DHA ViViRA on physical function, disease activity and quality of sleep compared to standard physiotherapy. We also evaluated the feasibility of ViViRA and conducted a cost analysis for both treatment approaches.

Methods:

axSpA patients participated in a randomized controlled trial and were assigned to either the DHA ViViRA (exercise app for lower back pain) intervention (series of exercises min. 15 minutes 2–3 x weekly) or continued conventional physiotherapy (min. 30 minutes once weekly). Questionnaires to physical function, sleep quality, disease activity, usability and acceptance were measured at baseline and after 12 weeks. The respective costs for physiotherapy and the use of the DHA ViViRA were determined from the perspective of statutory health insurance.

Results:

Data analysis of 59 participants (71.2% female, mean age 45.2 ± 11.18 years) revealed improvements in physical limitations (BASFI: 3.4 [2.7–4.1]; 3 [2.4–3.7]; $p = 0.041$, HAQ: 0.73 [0.58–0.88]; 0.65 [0.5–0.8]; $p = 0.046$), disease activity (ASDAS: 2.57 [2.28–2.86]; 2.24 [1.95–2.53], $p = 0.005$) and sleep quality (PSQI: 9.7 [8.5–11]; 8.8 [7.6–10]; $p = 0.0181$) in both groups from baseline to follow-up. A subgroup analysis of the ViViRA group indicated high usability (SUS: 82.58 ± 15.00) and acceptance (7.85/10 points) of the app. An exemplary cost analysis suggested potential cost savings for the ViViRA group.

Conclusion:

DMT utilizing the ViViRA app positively influenced physical function and sleep quality in axSpA patients. In terms of user experience, the app was rated as user-friendly and well-received. While our preliminary analysis suggests that ViViRA may reduce direct costs, further research is necessary to comprehensively evaluate its full cost-effectiveness.

Trial registration

Introduction

Physical activity (PA) offers many health benefits health, for example the reduction of cardiovascular events and preventing diseases, such as osteoporosis or obesity [1]. The world health organization (WHO) defines physical activity” as movements during leisure time, for transport to get to and from places, or as part of a person’s work or domestic activities” [2] and recommends: “at least 150–300 minutes of moderate-intensity aerobic PA for substantial health benefits” [5]. For patients with axial Spondyloarthritis (axSpAs), a chronic inflammatory disease primarily affecting the spine, regular PA is particularly beneficial for physical function and disease activity [3, 4] especially in supervised exercise groups [6].

We recently demonstrated that digital movement therapy (DMT) delivered via a digital health application (DHA) showed a slight improvement in mobility and pain in 30 axSpA patients, suggesting a subtle superiority over traditional physiotherapy [7]; other important health outcomes such as sleep quality or physical function were not assessed in this analysis. Sleep quality has an important influence on chronic diseases, e.g. poor sleep is a predictor for more pain and worse quality of life in axSpA patients [8]. Physical function, as described above, is essential for performing everyday activities and affects quality of life as well. Both factors not only impact quality of life but also affect work productivity.

DHA are health apps for smartphones and empower patients to actively participate in their healing process [9]. There are several benefits of DHA: individual movement therapy, independence of time and place, participation in the decision-making process; on the other hand, there are challenges: safety, usefulness, data privacy and differentiation between fitness apps and clinically tested DHAs. The 2021 EULAR recommendations on self-management of rheumatic diseases, despite advocating for digital healthcare, do not explicitly detail DMT or DHA applications [10] and recognized DHA for DMT specifically within the field of rheumatology are scarce [11]. Although promising apps like Axia are emerging, its results were not available at the time of our study, and initial results had not been published [12]. Rheumatism-specific movement app that are available for all patients are desirable but currently there are mainly general apps for DMT. For instance, the Kaia app (<https://kaiahealth.de/rueckenschmerzen/>), an approved DHA for chronic back pain, showed a significant improvement in pain after 12 weeks of training compared to physiotherapy in a prospective, randomized intervention study [13].

Similarly, ViViRA, also a DHA for chronic back pain since 2019, showed in a controlled, randomized study involving 3629 patients demonstrated a significant improvement in pain perception after 12 weeks with this app [14].

These studies indicate that DHAs utilized for DMT can effectively contribute to pain reduction in individuals suffering from chronic back pain.

Recognizing these gaps and the potential for DHAs to supplement, bridge, or even replace conventional exercise treatment [15, 16], this study aims to provide a more holistic picture. Previous cost-effectiveness analyses for DHAs in other conditions have shown that while supplementary use may increase direct costs, it can be justified by improved health outcomes [17, 18]. For this study, we specifically focus on a cost scenario where the DHA ViViRA would be an alternative to standard physiotherapy.

This study aimed to evaluate the impact of the ViViRA app on physical function, disease activity and sleep quality in axSpA patients, complementing its previously demonstrated effects on mobility, pain, and quality of life. Additionally, we investigated the app's usability and acceptance to assess its practical applicability. We also aimed to characterize the profiles of the app users and to identify predictive factors for its acceptance and adherence. A cost analysis was also performed to determine whether app use could reduce healthcare expenditures

Methods

Patient recruitment

We conducted a prospective, randomized, non-blinded, controlled study (DRKS00031254). Patients were recruited between February 2023 and January 2024 from the outpatient clinics of the Department of Rheumatology and Immunology at the Universitätsklinikum Erlangen, Germany. Inclusion criteria were: diagnosis of axial spondyloarthritis (ASAS criteria 2009) without any changes in their medication in the last three months, age between 18 and 70 years and presence of chronic lower back pain [19]. Exclusion criteria were pregnancy and comorbidities according to the contraindications for using the DHA ViViRA [20]. The patient characteristics in the group distribution were homogeneous.

Ethical Considerations

The study was approved by the medical faculty ethics committee of the Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany (22-425-Bm) and registered in the German Clinical Trials Register (ViPA, DRKS00031254, 10.02.2023). The study was reported based on the CONSORT guidelines. Participation in the study voluntary and written informed consent was obtained before inclusion. Withdrawal from the study was possible at any time. The study was conducted in accordance with the ethical guidelines of the Declaration of Helsinki.

Data Storage

All patient data was pseudonymized. Collected data was stored and analyzed in a password-protected database (REDCap) to which only previously defined and authorized persons had access [21].

Study design

After giving their consent to study participation, the patients were randomized either to an intervention group with the DHA ViViRA or the physiotherapy control group by the study leader using a random number generator function in Microsoft Excel. There was restricted access to the randomization tool.

Patients of the intervention group received their first prescription for the DHA ViViRA at the baseline visit and were encouraged to exercise for around 15 minutes (3–5 exercises in ViViRA) for three times per week. All patients in the intervention group used the DHA ViViRA for the first time. The control group continued with physiotherapy once a week according to the standard of care with a duration of at least 30 minutes per week. The physiotherapy units were specified for back pain and also tailored to individual fitness levels and disease activity. Patients were asked to protocol discomfort and injuries during the exercises. Questionnaires were sent digitally via REDCap (Research Electronic Data Capture) at baseline and after 12 weeks to the patients.

Patient reported outcome measures

The following validated patient reported outcomes measures on physical function were collected: Health Assessment Questionnaire (HAQ) and Bath Ankylosing Spondylitis Functional Index (BASFI) for physical function, Pittsburgh Sleep Quality Index (PSQI) for quality of sleep, Ankylosing Spondylitis Disease Activity Score (ASDAS) for disease activity, Work Productivity and Activity Impairment (WPAI) for work productivity, System Usability Scale (SUS) for usability, Net Promoter Score (NPS) for the acceptance of the app, Technikbereitschaft (TB) for the affinity to technologies. Detailed information for all questionnaires is summarized in the supplements (Supplementary Table S1). The questionnaires used in this study are widely recognized as reliable instruments in clinical and digital research.

Cost analysis

The respective costs for a unit of physiotherapy, physiotherapy equipment and manual therapy were determined based on the official pricing for therapeutic products in accordance with § 125 German SGB V (Code of Social Law V). Using these standard rates, the cumulative costs per study group over the 12-week duration were calculated. To ensure comparability with the quarterly cost of ViViRA, the costs for the control group were extrapolated to a quarterly period. The cost of ViViRA was set at 207 Euros per patient for a quarterly period, as specified by the German BfArM (Federal Institute for Drugs and Medical Devices, 2023d).

Statistical analysis

The sample size was calculated to detect a mean difference in the Bath Ankylosing Spondylitis Functional Index (BASFI) score between the intervention and control groups. Based on a desired power of 80% and a two-sided significance level (α) of 0.005, and assuming a standard deviation of 1.5 for the

BASFI score, a sample size of approximately 15 participants per group was required to detect a clinically meaningful difference of 2 points.

Health Outcomes (BASFI, HAQ, PSQI, WPAI):

All statistical analyses regarding health outcomes were conducted in R 4.4.1® (R Core Team, Vienna, Austria) for Windows 10®. The *rstatix* package was used for two-way mixed ANOVAs and assumption checks, while the *WRS2* package facilitated robust two-way mixed ANOVA [30, 31]. Estimated marginal means and their 95% confidence intervals (95% CI) were computed using the *emmeans* package, which was also used for pairwise comparisons [32]. Specifically, a two-way mixed ANOVA was conducted to assess the interaction between time and intervention, with time treated as a within-subjects factor and intervention as a fixed effect. Additionally, two-way mixed ANOVAs were performed to explore potential interactions between time and age and between time and sex. Age groups were defined based on the overall median age. If any assumptions required for these tests—namely, normality of residuals, homogeneity of covariances, or sphericity—were violated, a robust two-way mixed ANOVA was applied. Main effects were analyzed using estimated marginal means (*emmeans*) with pairwise comparisons, and the Benjamini-Hochberg procedure was employed to correct for multiple comparisons.

Usability and acceptance:

The statistical analysis for *usability* and *acceptance* was performed with IBM SPSS Statistics V.20 Windows (SPSS Inc., Chicago, Illinois, USA) and Excel Windows (Microsoft GmbH, Unterschleißheim, Germany). Descriptive statistics are reported as arithmetic mean and standard deviation, normality was tested with the Kolmogorov-Smirnov test. The Pearson correlation coefficient *r* was determined for the dependency of two variables. Linear regression was used to explain the variation in the response variable that can be attributed to variation in the explanatory variables. The effect size was calculated using the beta coefficient. In linear regression, R-squared was used as standard. For multiple regressions, the adapted R-squared was used.

Results

Patient health outcomes

Fifty-nine patients completed the study. The patient characteristics at baseline are summarized in table 1.

Initially, 70 patients were recruited, with 7 dropping out before the start of the study for personal reasons (Patient flow in supplement Figure S2). 4 patients were lost to follow-up. The patient characteristics in the group distribution were homogeneous. Participants had stable disease activity without any changes in their medication. Most patients were on biologicals, NSAIDs as needed, or no medication for long-term drug therapy.

Forty-two participants were (71.2 %) women. The overall mean age was 45.15 ± 11.18 years [range 20-65 years] and the mean Body mass index (BMI) 27.24 ± 5.08 kg/m² [range 18-43 kg/m²]. However, there was a group effect ($p=0.035$), with participants being younger (43.4 [39.3-47.5]) in the intervention group than the control group (47.5 [43.3-51.6]).

The patient health outcomes of both groups at baseline and follow-up are summarized in table 1 and table 2.

Limitations in physical function (HAQ, BASFI)

The HAQ decreased similarly between baseline and follow-up in both groups (baseline: 0.73 [range 0.58-0.88]; follow-up: 0.65 [range 0.5-0.8]; $p=0.046$). Limitations in physical function remained higher for females (0.82 [range 0.66-0.99] vs. 0.37 [range 0.11-0.62]; $p = 0.004$) and older participants (<45 years: 0.50 [range 0.32-0.68] vs. ≥ 45 years: 0.93 [range 0.72-1.1]; $p = 0.001$). The HAQ decreased between baseline and follow-up for those which improved work productivity and had less activity impairment (reduced WPAI) (WPAI baseline: 0.67 [range 0.41-0.93]; follow-up: 0.45 [range 0.19-0.71]; $p=0.001$).

BASFI Score decrease from baseline to follow-up in both groups, without a group difference (baseline: 3.4 [range 2.7-4.1]; follow-up: 3 [range 2.4-3.7]; $p=0.041$).

The BASFI score was lower in younger participants (<45 years: 2.4 [range 1.6-3.2] vs. ≥ 45 years: 4.3 [range 3.4-5.2]; $p = 0.003$), but no differences were found between females and males (3.6 [range 2.8-4.3] vs. 2.4 [range 1.2-3.6]; $p = 0.10$). When the work productivity increased and activity impairment decreased (reduced WPAI) between baseline and follow-up, the functional limitations decreased as well (baseline: 2.9 [range 1.8-4.1]; follow-up: 1.9 [range 0.77-3.1]; $p=0.001$).

Sleep quality (PSQI)

PSQI Score improved in both the intervention and control groups from baseline to follow-up (baseline: 9.7 [8.5-11]; follow-up: 8.8 [7.6-10], $p = 0.0181$). Females had poorer sleep quality than males (10 [range 8.7-11] vs. 7.4 [range 5.4-9.4]; $p = 0.03$). No age-related differences were observed (8.6 [range 7.1-10] vs. 10 [range 8.4-12]; $p = 0.20$).

Disease Activity (ASDAS)

A two-way mixed ANOVA revealed no significant group or interaction effect for ASDAS (Ankylosing Spondylitis Disease Activity Score). However, a significant time effect was observed ($p=0.005$), indicating a decrease in ASDAS scores from baseline (2.57 [95% CI: 2.28-2.86]) to follow-up (2.24 [95% CI: 1.95-2.53]). When looking at the subgroup of patients that would continue using the app in the future, a significant time effect was present ($p=0.019$), with lower ASDAS scores at follow-up (2.13 [95% CI: 1.62-2.64]) compared to baseline (2.61 [95% CI: 2.10-3.12]).

Usability and acceptance

Thirty-three participants (ten men (30.3 %), 23 women (69.7%); average age 41.27 ± 11.48 years) of the intervention group completed the usability survey for the DHA ViViRA. The results are summarized in Table 3.

Exploration of user characteristics

The higher the level of pain (measured by PAIN-DETECT), the higher the acceptance of the app (beta=0.360; $R^2=0.130$; $p=0.039$), especially in patients ≤ 30 years (beta=0.877; $R^2=0.769$; $p=0.022$). There was a significant correlation between measured pain and acceptance ($r=0.985$, $p<0.000$).

The higher the perceived usability, the higher the affinity for technology (technology competence conviction, technology acceptance, technology control conviction) (beta=0.456; adjusted $R^2=0.248$; $p=0.039$).

Cost-analysis

In the control group, 29 patients were monitored, who received varying forms of physiotherapy, including general physiotherapy, equipment-based physiotherapy and massage therapy. Using the pricing data established in the methodology section, the cumulative cost burden for physiotherapy treatments over one quarter was calculated, amounting to 24,863.95 Euros. Considering the mandatory patient co-payment of 10 percent as stipulated by § 61 SGB V, the net financial burden for the statutory health insurance was 22,377.56 Euros.

The cost of the DHA over the quarter was determined at 206.79 Euros per patient, leading to a total cost of 5,996.91 Euros. Additionally, reimbursement regulations allow for a physician evaluation fee of 7.35 Euros per patient, resulting in a total expenditure of 6,210.06 Euros for the DHA cohort. Thus, substituting physiotherapy with ViViRA resulted in cost savings of 16,167.50 Euros for the 29 patients analyzed. This calculation assumes full adherence to the app and complete replacement of physiotherapy.

Discussion

The main aspect of our study was to compare physical function, disease activity, and quality of sleep of digital movement therapy (DMT) with physiotherapy in patients with axSpA. In addition to the specific health outcomes, our study also aimed to evaluate the usability of the DHA, the user characteristics and its associated healthcare costs.

Our results showed that DMT had similar health outcomes to standard physiotherapy. In both groups the limitations in physical function (by HAQ and BASFI) improved over the 12 weeks intervention period which is in line with previous literature. Both, physiotherapy and other exercise programs have been reported to improve physical function of axSpA patients with [33, 34], and also online physiotherapy can improve quality of life, pain and physical function [35, 36]. However, it is important to note that

participants in this study received close supervision and highly individualized online physiotherapy. We here show for the first time, that DMT shows similar effects compared to standard of care physiotherapy. Notably, these results were observed without providing close monitoring or a personalized exercise regimen

Patients with axSpA suffer from sleep disorders which worsen with less PA [37]. In our study the sleep quality of the participants improved after exercising with ViViRA or physiotherapy and confirms findings of a systematic review and meta-analysis (22 randomized controlled studies with 1806 participants) which reported better sleep quality in adults through regular exercise over at least two months [38].

In terms of the usability of the DHA ViViRA, a positive result was achieved with around 83/100 points (> 68 points indicates good usability). Good average values were also achieved in the area of acceptance: almost half of the study participants would recommend the application to others.

Labinsky et al. showed a generally high acceptance of the DHAs (7.8/10 points), but lack of time and motivation were given as possible reasons for non-use [39]. The lack of motivation appears to be a major problem in the acceptance of DHA, so it is particularly important to look at ways in which this can be improved [40]. After all, 35% of patients who used the app regularly in the previous study showed a significant improvement in their symptoms, which can also be seen as intrinsic motivation for regular use and exercise [41]. Especially when disease activity improves, patients are motivated to continue using the app. In our study, pain was strongly correlated to the acceptance to the app, maybe the severity of pain has acted as a key driver of adherence to the app-based exercise program.

Participants in our intervention group were younger compared to the control group. Young patients are often well versed in the use of digital media and explicitly ask about new technologies that can improve the course of their disease. In their survey Knitza et al. 2020 reported that patients with rheumatic diseases particularly appreciate the use of digital media and would use them more frequently if they were available for rheumatology [42]. In a study conducted in 2022, patients were very interested in apps or other digital technologies that they could use to get in touch with doctors, so there is generally a high demand for digital apps among rheumatic patients [43].

Our survey examined also the relationship between affinity for technology and perceived usability. The more competent the patients consider themselves to be, the higher the perceived usability. In a recently published survey, patients with rheumatic diseases were asked what they generally think of DHAs [44]. The results on the usability of DHAs showed very high scores (5.96 out of 7 possible points) and a significant improvement in quality of life and disease activity while using the apps. Digital movement therapy may offer significant advantages over traditional in-person care, primarily by enhancing flexibility and access for patients. This approach allows individuals to perform exercises at their convenience and from the comfort of their homes, overcoming logistical barriers such as travel time, costs, and scheduling conflicts. The increased accessibility is particularly beneficial for patients in rural areas or those with limited mobility or limited access to physiotherapy practices. It is clearly important to identify

who benefit from on-site physiotherapy and who from digital movement therapy or a combination of the two.

In addition to the comparable clinical effectiveness of DMT and standard physiotherapy, the short-term economic impact of DHA like ViViRA must be considered. Our cost analysis focuses solely on direct reimbursable treatment costs from the payer's perspective and is only a hypothetical calculation. A full cost-effectiveness or cost-utility analysis including long-term outcomes or indirect costs, was not part of this study. DHAs can serve as a lower-cost, complementary movement therapy, offering a flexible solution to overcome common healthcare barriers. Such applications can be used to supplement in-person care (e.g., combining once-weekly physiotherapy with 2–3 app-based sessions) or to fill gaps between physiotherapy prescriptions. This approach is particularly valuable for enabling the immediate onset of therapy when faced with long wait times or limited therapist availability [45]. Moreover, DHAs are an effective tool for increasing overall physical activity—a goal that is often difficult to achieve with periodic physiotherapy sessions alone—and can improve access to care for patients in regions with difficult infrastructure. However, further research is needed to confirm long-term cost-effectiveness in real-world settings.

These findings underscore the need for better integrating movement therapy into routine clinical practice, particularly through digital platforms. This approach is consistent with established recommendations, such as the 2016 EULAR guidelines, which recognize the crucial role of lifestyle modifications like regular exercise in disease management and prevention [46].

Limitations

Our study had some limitations. As mentioned above, further studies with longer observation periods and different exercise regimes are needed to better analyze the long-term effects of physical function and quality of sleep. Further studies with a higher number of patients might detect and demonstrate differences between the groups. The term "standard physiotherapy" encompasses a wide range of treatments, so it would be good to better define the type of physiotherapy. Of course, a DHA can also be given in combination with an existing therapy to further improve the health effects. In this case, the cost analysis is much more difficult because indirect cost savings from fewer visits to the doctor, medication, etc. would have to be calculated.

Conclusion and future directions

This study provides important results on movement therapies in axSpA patients and shows health and economic benefits, especially of DMT that have not been regularly reported in movement studies. In our study health outcomes of digital movement therapy, in this case with the DHA ViViRA, are equal to the standardized physiotherapy treatment. Although the app is accepted by rheumatic patients as user-friendly and cost-effective, it must be decided on an individual basis which patient will benefit from this treatment. Especially when there are shortages in physiotherapy treatment, the use of a DHA in the area of movement therapy could be equally efficient and cost-saving. The results suggest that future studies

should further investigate the determinants (barriers and facilitators) for the use of digital health technologies in rheumatic patients to better tailor clinical care, i.e. to identify which patients respond better to DHA or physiotherapy.

Abbreviations

AxSpA
Axial Spondyloarthritis
DHA
Digital health application
DMT
Digital movement therapy:SUS:System usability scale
NPS
Net promoter score
EULAR
European League Against Rheumatism
PA
Physical activity
WHO
World health organization
ASAS
The Assessment in SpondyloArthritis International Society
REDCap
Research Electronic Data Capture
HAQ
Health Assessment Questionnaire
BASFI
Bath Ankylosing Spondylitis Functional Index
PSQI
Pittsburgh Sleep Quality Index
ASDAS
Ankylosing Spondylitis Disease Activity Score
WPAI
Work Productivity and Activity Impairment
TB
Technikbereitschaft
NRS
Numeric rating scale
BfArM
Federal Institute for Drugs and Medical Devices

BMI
Body Mass Index
SD
Standard deviation

Declarations

Ethics approval and consent to participate:

The study protocol was approved by the medical faculty ethics committee of the Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany (22-425-Bm). Participation in the study was voluntary. All patients gave their written informed consent before study inclusion.

Consent for publication:

Not applicable.

Competing interests:

The authors declare no competing interests.

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All the authors discussed the results, reviewed the draft and provided comments for change. All of them contributed to the final paper.

Author Contribution

P.PAB and N.K. share the first authorship. The present work is part of the bachelor thesis of the author NK (Gesundheitsökonomie – Health Care Economics, Wiesbaden Business School der Hochschule RheinMain, Germany) and master thesis of the last author HM (University of Applied Sciences BFI Vienna, Austria).

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Data Availability

The data sets are available on reasonable request from the corresponding author.

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Tables

Table 1: Patient characteristics at baseline in a randomized-controlled study of 59 axSpA-patients (71.2% female, 28.8% male) in Erlangen, Germany, from February 2023 to January 2024.

Patient characteristics	All patients (n = 59)	Intervention (n = 30)	Control (n = 29)
Age [years] <i>mean ± SD</i>	45.15 ± 11.18	43.13 ± 11.25	47.24 ± 11.12
Sex female <i>number (%)</i>	n = 42 (71,2%)	n = 21 (70%)	n = 21 (72,4%)
HAQ <i>mean ± SD</i>	0.73 ± 0.59	0.69 ± 0.66	0.77 ± 0.51
WPAI <i>mean ± SD</i>	43 ± 28	42 ± 30	44 ± 26
BASFI <i>mean ± SD</i>	3.4 ± 2.6	3.2 ± 2.7	3.7 ± 2.4
PSQI <i>mean ± SD</i>	9.7 ± 4.4	9.4 ± 4.9	10 ± 3.8

WPAI Work Productivity and Activity Impairment Questionnaire, HAQ Health Assessment Questionnaire, BASFI Bath Ankylosing Spondylitis Functional Index, PSQI Pittsburgh Sleep Quality Index.

Table 2: Patient characteristics at follow-up in a randomized-controlled study of 59 axSpA-patients (71.2% female, 28.8% male) in Erlangen, Germany, from February 2023 to January 2024.

Patient characteristics	All patients (n = 59)	Intervention (n = 30)	Control (n = 29)
HAQ <i>mean ± SD</i>	0.65 ± 0.59	0.63 ± 0.63	0.67 ± 0.56
WPAI <i>mean ± SD</i>	37 ± 28	36 ± 29	39 ± 26
BASFI <i>mean ± SD</i>	3 ± 2.7	2.7 ± 2.8	3.4 ± 2.6
PSQI <i>mean ± SD</i>	8.8 ± 4.7	8.7 ± 4.7	9 ± 4.8

Table 3: Usability and acceptance of the DHA ViViRA. Patient characteristics overall of 33 axSpA-patients that used the DHA ViViRA (69.7 % female, 30.3% male) in Erlangen, Germany, from February 2023 to January 2024.

Usability and Acceptance	Patients (n = 33)
SUS (0-100)	82.58 ± 15.00
<i>mean ± SD</i>	
Technology Commitment	46.06 ± 6.69
<i>mean ± SD</i>	
NPS-Scale	7.85 ± 1.97
<i>mean ± SD</i>	
<i>detractor</i>	7 (21.2%)
<i>neutral</i>	12 (36.4%)
<i>promoter</i>	14 (42.4%)

SUS System Usability Scale, NPS-Scale NET Promoter Scale.

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