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Adherence to home exercises in non-specific low back pain. A randomised controlled pilot trial

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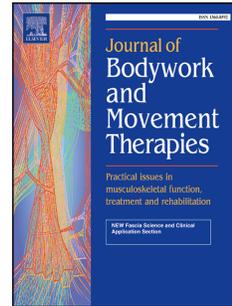
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## Abstract

Specific exercises for the improvement of movement control of the lumbopelvic region are well-established for patients with non-specific low back pain (NSLBP) and movement control impairment (MCI). However, a lack of adherence to home exercise regimens is often observed. The aim of the study was to explore the differences in home exercise (HE) adherence between patients who perform conventional exercises and those who exercise with Augmented Feedback (AF).

Twenty patients with NSLBP and MCI were randomly allocated into two groups. The physiotherapy group (PT group) completed conventional exercises, and the AF group exercised with an AF system that was designed for use in therapy settings. The main outcome measure was self-reported adherence to the home exercise regimen.

There was no significant difference in HE duration between the groups ( $W= 64$ ,  $p= 0.315$ ). The AF group exercised for a median of 9 min and 4 s (IQR= 3'59"), and the PT group exercised for 4 min and 19 s (IQR= 8'30").

Exercising with AF led to HE times that were similar to those of conventional exercise, and AF might be used as an alternative therapy method for home exercise.

Keywords:

non-specific low back pain, movement control impairment, Augmented Feedback, adherence, home exercises

## INTRODUCTION

Chronic low back pain is a substantial socioeconomic problem in today's society, and 84% of the population will experience an episode of low back pain (LBP) in their lifetime (Airaksinen et al 2006, Nachemson 1999). Most patients recover within four weeks; however, 23% of patients develop chronic LBP (Airaksinen et al 2006, Nachemson 2004) that is not resolved within a year (Henschke et al 2008, Stanton et al 2008). Non-specific LBP (NSLBP) is diagnosed in 85% of all patients with LBP (Airaksinen et al 2006, Van Dillen et al 1998). A subgroup of these patients suffers from movement control impairment (MCI) of the lumbar spine according to O'Sullivan (O'Sullivan 2005). The lack of movement awareness and control of the lumbopelvic region leads to an inappropriate movement behaviour with provocative movement and posture patterns. According to previous authors, this mechanism leads to a tissue overload and mechanically provoked pain (Dankaerts et al 2007, O'Sullivan 2005). Impairment-specific exercises for movement awareness and control of the lumbopelvic region are effective for patients with NSLBP and movement control impairment (Costa et al 2009, Macedo et al 2012). However, traditional exercises are often considered monotonous, which leads to discontinuation, particularly at home (Burke et al 2009, Duncan et al 2002, Becker 1985). However, the effect of the therapy relies on the adherence of the patient to the performance of the exercises not only in therapy setting but also at home (Mannion et al 2009, van Gool et al 2005). A previous study demonstrated that non-adherence to treatment and exercises occurs in up to 70% of all patients

and consequently adversely affects treatment effectiveness and costs (Sluijs et al 1993). The reasons for a lack of adherence to the regimen of regularly exercise might include the complexity of the movements and the lack of feedback during HE (Brodbeck 2009a, Brodbeck 2009b, Escolar-Reina et al 2010). Adherence is defined by the active cooperation and the attitude of the patient during the therapy session and during HE execution (Meichenbaum&Turk 1987). Adherence can be measured through patient self-assessments, recording of the numbers of minutes spent exercising at home, or ratings of the therapist based on questionnaires. Previous studies have shown that patients exhibit a greater enthusiasm for exercise execution during training with a computer-animated Augmented Feedback (AF) system (Nitzsche&Schulz 2011). In training movement control with Augmented Feedback the movements are executed and controlled by the lumbar spine.

Thus far, only a moderate correlation between cooperation during therapy sessions and HE adherence has been reported (Kolt&McEvoy 2003). Because the level of adherence associated with AF training is not known, we investigated this association in a pilot trial.

The primary research question was the following:

1. Is there a difference in HE adherence between patients with conventional HE and patients who exercised with AF?

The secondary research questions were as follows:

2. What is the correlation between self-assessed adherence and therapist-rated adherence?

3. Does training with AF lead to different changes in self-perceived disability and lumbar movement control compared to those elicited by conventional physiotherapy?

ACCEPTED MANUSCRIPT

## METHODS

### Study design

The study was designed as a randomised controlled pilot trial. Eligible patients were recruited from October 2012 to April 2013 in Winterthur, Switzerland.

### Subjects

Patients between the ages of 18-65 years were recruited at the front desk of physiotherapy practice, at a fitness studio and from a university campus via posters. The included patients had experienced NSLBP for longer than four weeks and at least moderate disability as indicated by an Oswestry disability index (ODI) >8% (Mannion et al 2006a, Mannion et al 2006b) and exhibited low levels of biopsychosocial risk factors (STarT Back Screening tool > 4 points) (Hill et al 2011). The patients had MCIs of at least two points according to the rating system of Luomajoki and colleagues (Luomajoki et al 2007, Luomajoki et al 2008). Patients with specific LBP, pain in other areas of the body (e.g. neck, head, thoracic spine or arms), vertigo or equilibrium disturbances, systemic diseases (e.g. tumours and diabetes), complaints, injuries or surgeries of the legs within the last six months, medication affecting postural control and pregnancy were excluded. All patients provided written informed consent prior to the study. The trial was approved by the Ethics committee of the canton Zurich, Switzerland (KEK-ZH-Nr. 2011-0522).

### Randomisation

A computer-generated randomisation was performed. The patients were randomly allocated into blocks of four, within one of two treatment arms. The randomisation was performed concealed by a blinded individual who was not involved in this study.

### Outcome measures

Self-assessed adherence was measured using a home exercise (HE) diary. Every day, the patients filled in a simple spreadsheet with the date and the duration of the exercises performed that day in minutes. The total duration of HE was calculated and divided by the number of days from the first to the last therapy session, including days on which no home exercises were performed (i.e. the average home exercise time per day was calculated). As a secondary outcome measure, the attending therapist rated the adherence of their patients using the “sport injury rehabilitation adherence scale” (SIRAS). The SIRAS contains three questions that are rated on a five-point Likert scale concerning patient participation, attentiveness and instruction following (Brewer et al 2000, Kolt et al 2007).

The Oswestry Disability Index (ODI) (Mannion et al 2006a, Mannion et al 2006b) and the Patient Specific Functional Scale (PSFS) were used (Stratford&Binkley 2000) to assess self-perceived disability due to LBP. Movement control impairment (MCI) tests were used to assess the patients' movement control of their lumbar spines. The tests included six movements that

were executed by the patient and rated by a therapist who evaluates movement control of the spine in the directions of flexion, extension and rotation (Luomajoki et al 2008, Luomajoki et al 2007, Luomajoki et al 2010).

A German questionnaire that assesses the affinity for and concerns about working with computers (Fragebogen zur Sicherheit im Umgang mit Computern und Computeranwendungen COMA) was completed by the patients. The COMA was used to determine whether the affinity for or concerns about the use computers represented possible confounders of the primary outcome of using AF systems in the HE (Richter et al 2010).

### Procedure

The patients were pre-screened by their physiotherapists prior to selection for the study. The principal investigator (AH) ultimately examined all patients for eligibility. After inclusion, the patients were allocated to one of the two treatment arms. The outcome measures were recorded at the beginning and at the end of nine therapy sessions (Swiss standard prescription) by the attending therapists (using the SIRAS) and by the patients themselves (self-assessed adherence). Within both groups the exercises were conducted to improve movement control and awareness of the lumbar spine.

A selection of HEs from an exercise catalogue was summarised for the physiotherapists. Each patient performed impairment-specific exercises. Both groups received an HE program consisting of three to five exercises that required 10 to 20 minutes to complete each day. In both groups, passive

therapy interventions were reduced to a maximum of one-third of each session (Saner et al 2011). Furthermore, the patients were asked not to follow additional exercise interventions during the trial. The AF group performed the same exercises as the PT group during the therapy sessions and during the HE, but the AF group also used the Valedo®Motion AF system. The Valedo®Motion system consists of a laptop and two sensors that are attached to the L1 and S1 spinal processes. The patients in the AF group exercised with games that were specially developed for movement control, body awareness, and stabilisation that are controlled by lower back movements (Fig. 1). The Valedo®Motion system provides a real-time feedback regarding the patient's performance and helps to correct the execution of the exercises (Fig. 2). This product was designed for low back pain treatments in therapeutic settings (Hocoma, Switzerland). Because the allocation was concealed, but the measurements were not blinded, the principle investigator also performed all of the therapy sessions for the AF group. No blinding of the patients or the therapists was possible.

#### Data analyses

The R language and environment for statistical computing (<http://www.R-project.org> 2012) was used for the statistical analyses. Non-parametric methods were used. The Wilcoxon rank sum test was used to calculate the difference in the home exercise durations between the groups. The correlation between self-reported and therapist-rated adherence was calculated using Spearman's rho.

The Wilcoxon rank sum test was also used to calculate the between-group differences in self-perceived disabilities (ODI, PSFS). Differences in the proportions of positively rated MCI tests between the groups were analysed using  $X^2$  statistics. The level of significance was set at  $\alpha= 0.05$ .

## RESULTS

Thirty-six patients were tested for eligibility, and 20 patients (eight female) were included in the trial (Table 1). There were no drop outs during the trial (Fig. 3). No patients in either group had concerns about using computers as measured by the COMA questionnaire ( $W=57$   $p= 0.6$ ). At the beginning of the trial, there were no significant differences in the ODI, PSFS or MCI between the two groups (Table 2).

### Primary outcome

The AF group exercised for a median time of 9'4" (IQR=3'59"), and the PT group exercised for 4'19" (IQR=8'30"). There was no significant difference in the duration of home exercises (HE) between both the groups ( $W=64$ ,  $p=0.315$ ). However, the AF group exhibited a tendency for longer HE durations (Fig. 4). A gender  $X$  group effect on the daily duration of home exercise was observed and analysed with a  $X^2$  test ( $H=7.99$ ,  $p=0.046$ ). The women in the AF group (8'09", IQR=3'3") trained more than women in the PT group (3.49 min,

IQR=1'2"). The opposite pattern was observed among the men; the AF group exercised for 9.05 min (IQR=2'25"), and the men in the PT group exercised for 12 min (IQR=3'01"). However, a post hoc Wilcoxon rank sum test did not confirm this effect due to the small number of subjects (Fig. 5).

### Secondary outcomes

The correlation between the therapist-rated and the self-reported adherences across the entire sample was fair (0.33,  $p=0.16$ ). Within the AF group, the correlation was fair with a rho of 0.45 ( $p=0.19$ ). In the PT group the correlation was low (rho=0.13,  $p=0.73$ ).

Significant improvements in the ODI, PSFS, and MCI were observed for the entire sample (Table 3). At the end of therapy, there were no significant group differences in the ODI, PSFS or MCI (Table 4).

At the end of therapy, both groups exhibited decreased self-perceived disability as evaluated with the ODI ( $p= 0.0002$ ). The median scores of the AF group improved from 15% (IQR= 5.5) to 8% (IQR=7;  $p= 0.01$ ). The PT group improved from a median of 16% (IQR= 13) to 5% (IQR=10.5;  $p= 0.01$ ) (Table 4).

Each of the three activities of the PSFS were analysed separately. At baseline, no significant group difference was found for the first activity of the PSFS ( $p=0.79$ ). At the end of therapy, both groups exhibited decreases in self-perceived disability, although no group difference was observed ( $p= 0.32$ ). The median score of the AF group improved from 5.5 (IQR= 1.75) to 2.5 (IQR= 2.5;  $p= 0.001$ ), and the median score of the PT group improved from 6 (IQR= 3.75) to 1 (IQR= 2.75;  $p= 0.001$ ) (Table 4).

The results for the second and third activities of the PSFS were similar (Table 4).

At the end of therapy, the entire group exhibited a significant improvement in movement control ( $p= 0.004$ ). There was no significant group difference ( $p= 0.55$ ) nor were there significant within-group pre-post differences. The AF group improved in movement control ( $X^2=18.75$ ,  $p= 0.09$ ) as did the PT group ( $X^2= 10.97$ ;  $p= 0.28$ ) (Table 4).

## DISCUSSION

The results of this study revealed that the patients with non-specific low back pain performed equal amounts of movement control exercise regardless of the use of conventional methods or Augmented Feedback.

In the analysis with a correction for gender, a tendency toward an increase in exercise time among the women who used the AF system was found, and the opposite tendency was found among the men.

Moreover, no group or gender differences were found in self-assessed adherence. The correlations between self-assessed and therapist-rated adherences were only moderate in the AF group and low in the PT group. Both

groups exhibited similar improvements in movement control of the lumbar spine and similar decreases in self-perceived disability.

No significant differences between the exercises performed with Augmented Feedback in a game environment and those performed in conventional physiotherapy were observed. However, the AF group exhibited a tendency toward longer home exercise (HE) durations. This tendency might have been due to the additional motivation provided exercising within a game-like environment (Graves et al 2010).

The differences in the median exercise times were small; i.e., approximately five minutes (Fig. 4). Thus far no study has examined the amount of exercise time that is required or should be recommended for these types of home exercises within this patient group. Thus, at least in the short-term, the observed differences in median exercise times have no clinical value in terms of disability and movement control. The time required to benefit from the effects of exercise remains unclear.

Trends toward different HE durations between the men and women in both groups were found. The women exercised for a longer time period with the AF compared to conventional PT. The opposite trend was observed among the men (Fig. 5). Because the sample size was small and included only three women in the AF group (Table 1), the post-hoc tests did not confirm this trend even at the alpha level of 0.05. Moreover, previous studies have not confirmed this trend toward a gender difference (Sluijs et al 1993). Some studies of gender

differences in video gaming among healthy people have shown that men play more frequently and for a longer time period than women. Male players have also more playing experience and therefore achieve higher scores in video games (Greenberg et al 2010, Jansz et al 2010). However, it might be possible that, in the present study, the women were more attracted to the therapeutic game environment than were the men. The assumption that women generally adhere better to exercises recommended by their physiotherapists and therefore exercise for longer durations is not supported by our results because the women in the PT group exercised the least (Fig. 5). However, this trend should be considered cautiously because this study was designed as a pilot, and the random allocation led to an unequal gender distribution in the AF group (Tab. 1).

No comparable studies that have measured HE duration were found in the literature. Moseley described improved adherence to HE among patients with complex regional pain syndrome (CRPS) who knew that their HE durations were being measured by a computer tool (Moseley 2006). Unfortunately, no time values were reported in this study. Similarly, the computer-reported HE durations was not analysed in the present study because they were only recorded in the AF group.

One problem with self-assessed adherence is the registration of HE durations, which should be performed immediately after completing the exercises. Belated recordings of HE durations often lead to imprecise reports (Sallis and Saelens,

2000). Stone and colleagues assumed that the validity of home exercise diaries is questionable due to poor real-time compliance with diary completion (Stone et al 2003).

Earlier research has shown that adherence can be improved by the clear setting of the objectives of rehabilitation between the therapist and patient (Coppack et al., 2012). Home program should always be provided in written form and the therapist should provide regular feedback to the patient regarding their performance of the exercises. In this study it was not recorded whether the therapists provided written HE programs.

The effects of pausing during the HEs were not examined in this study. It remains unclear whether the exercise times the patients counted and registered included serial pauses that might have led to differences in the reported HE times. However, we assume the effects of this issue were similar between groups.

The correlations between the therapist-rated and self-reported adherences within the AF group were fair and within the PT group low. In general, therapists in both of the groups rated the patients' adherences as high, and no significant group difference was observed. One explanation for the fair correlation might be the low variability in the therapist-rated adherences. The provision of more detailed instructions to the therapists involved in the study might have improved the variability within the sample, via the application of stricter ratings. The fact that the patients knew that their adherence was rated by their therapists might

have influenced their motivation during the therapy sessions because a similar effect has been observed (Haynes et al 2008).

Both groups exhibited improvements in disability and movement control. The improvements in disability demonstrated that types of therapeutic interventions are effective for patients with LBP and movement control impairment. Because both groups performed the same exercises, it is not surprising that there were no between-group difference in self-perceived disability or movement control.

Following stroke, patients who play video games exhibit greater functional recovery than those who engage in traditional exercises. While working with task-orientated training in virtual reality environments, patients are required to perform mirrored motions and receive Augmented Feedback that leads to neuroplastic changes in the motor cortex (Johansen-Berg et al 2002, Rose et al 2000, Todorov et al 1997). Consequently, patients who learn movements with Augmented Feedback are more likely to retain and transfer skills than are patients who train in the real world (Todorov et al 1997). The same effect can appear in patients with NSCLBP and movement control impairments. This subgroup of patients has been shown to suffer from distorted body images (Moseley 2008, Luomajoki&Moseley 2011). AF training might benefit this group of patients in terms of regaining movement control and body awareness. Another important issue is the possibility that greater motivation is associated with the playing of computer games, which could result in a greater numbers of

repetitions and lead to the performance the quantity of exercises that is necessary to achieve cortical changes (Lang et al 2009).

The patients who trained with the AF system were required to return the system after the therapy sessions. Thus, the question of whether the patients were able to continue exercising without the AF system remains. No-follow up was conducted; therefore, whether the patients continued exercising after the therapy stopped remains unclear. Another flaw related to the usability of the AF system is that this system was developed for use in therapeutic settings. Some applications were difficult to use at home without the help of a therapist. The start-up of the AF system and the preparation of the sensors required several minutes. The development of a more user-friendly AF system for home-use is recommended.

The AF exercises were designed in an abstract manner (Fig. 1, Fig. 2); e.g., one exercise involved stabilising a plate with coconuts or a broken branch. Such abstractions might have been difficult for the patients to recognise, interpret and use to correct their exercise execution accordingly. In contrast to the AF group, the patients in the PT group were free to use other feedback methods such as a mirrors; the use of mirrors is a well-established feedback method in physiotherapy (Barona et al 1994, Lin et al 2012). Such feedback could potentially provide an explanation for the similar results observed in both groups, although we do not know whether feedback was used by the PT groups or, if so, what type of feedback was used.

The PSFS and the ODI are reliable and valid assessment instruments for measuring self-perceived disability. The levels of disability due to LBP were low in all patients. Some research has shown that the Roland and Morris disability questionnaire might be a better assessment instrument for patients with low levels of disability due to potential floor effect of the ODI (Roland&Fairbank 2000).

The MCI tests are reliable and have demonstrated good discriminative validity (Luomajoki et al 2008, Luomajoki et al 2007). Both groups demonstrated significant improvements in movement control according to these tests. However, more accurate and objective measurements, such as those produced by opto-electronic systems and inertial movement unit systems are recommended for the evaluation of changes in MCI.

### Limitations

The sample size was small because this study was designed as a pilot study. Neither patient nor therapist blinding was possible.

The patients' knowledge that their adherence was being measured by their therapists, likely altered their behaviour during the therapy sessions. The therapists always rated their patients' adherences high, which led to reduced variability.

There was no follow up and thus no control for HE program continuation after the end of the therapy. The AF group returned the AF systems and it is questionable whether they were able to continue the exercises without the AF systems. The AF system was not designed for use by patients on their own. A more user-friendly system is needed for home training.

Imprecise reporting of the home exercises (HE) durations might have influenced the results because the measurements of this primary outcome were based on a self-assessed test.

## CONCLUSION

Patients with LBP and movement control impairments can effectively exercise with the AF system. However, these exercises are not more effective than conventional physiotherapy exercises in terms of improved adherence to exercise regimens. There was a tendency for the AF group to perform HEs for longer durations. This difference in home exercise duration was approximately five minutes and did not have an additional effect on self-perceived disability in the short term. The importance of the time spent performing home exercises and the time that is required to achieve greater effects on self-perceived disability and movement control in the long term remain unknown.

AF might be used as an alternative or a supplementary method for patients who are likely to be attracted by this type of exercise. Depending on the type of patient, the playful characteristics of exercising with an AF system might lead to improved adherence to physiotherapy and HE programs. Women might particularly benefit from this type of exercise.

Additional and larger studies are needed. The following points should be considered:

- A meaningful per-day exercise duration should be established. In our study, the patients exercised for between four and ten minutes. A follow-up is needed to determine whether this amount of HE is sufficient in the long-term.
- The AF device should be optimised for home use.

- Better instructions regarding therapist-rated adherence should be created.
- A stratified randomisation process (by gender) should be employed.

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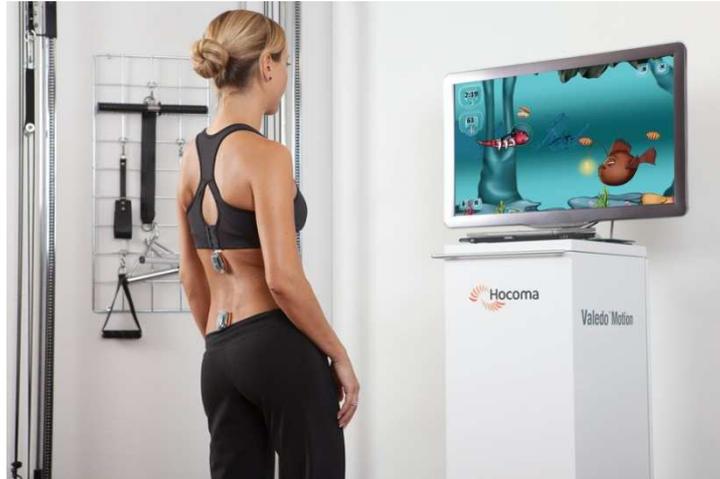
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**Figure 1: Valedo®Motion as Augmented Feedback**

Courtesy of Hocoma



**Figure 2: Exercise „balance mirror“**

**Table 1: Baseline characteristics**

n= 20		All subjects	AF group	PT group	p-value
Age [Years], (m, sd) <sup>a</sup>		3.65 (12.96)	34.2 (11.58)	37.1 (1.,62)	p= 0.63
Sex [n], (%) <sup>c</sup>	men	12 (60%)	7 (35%)	5 (25%)	p= 0.65
	women	8 (40%)	3 (15%)	5 (25%)	
Total days in treatment (m, sd) <sup>a</sup>		49.15 (15.67)	47.2 (12.96)	51,1 (9.82)	p= 0.59
STarT back screening tool Total (Med, IQR) <sup>b</sup>		2.5 (1.25)	2 (1.75)	3 (1.75)	p= 0.39
STarT back screening tool, psychosocial subscale (Med, IQR) <sup>b</sup>		1 (2)	1 (0.75)	0.5 (2.75)	p= 0.91
COMA (m; sd) <sup>b</sup>		1.75 (1)	2 (0.88)	1.25 (1)	p= 0.6

n: subjects; AF: Augmented Feedback; PT: conventional physiotherapy; m: mean; sd: standard deviation; Med: Median; IQR: Interquartile range; <sup>a</sup> t-test; <sup>b</sup> Wilcoxon Rank sum Test; <sup>c</sup> X<sup>2</sup> Test; COMA: Questionnaire about affinity and fear of using computer.

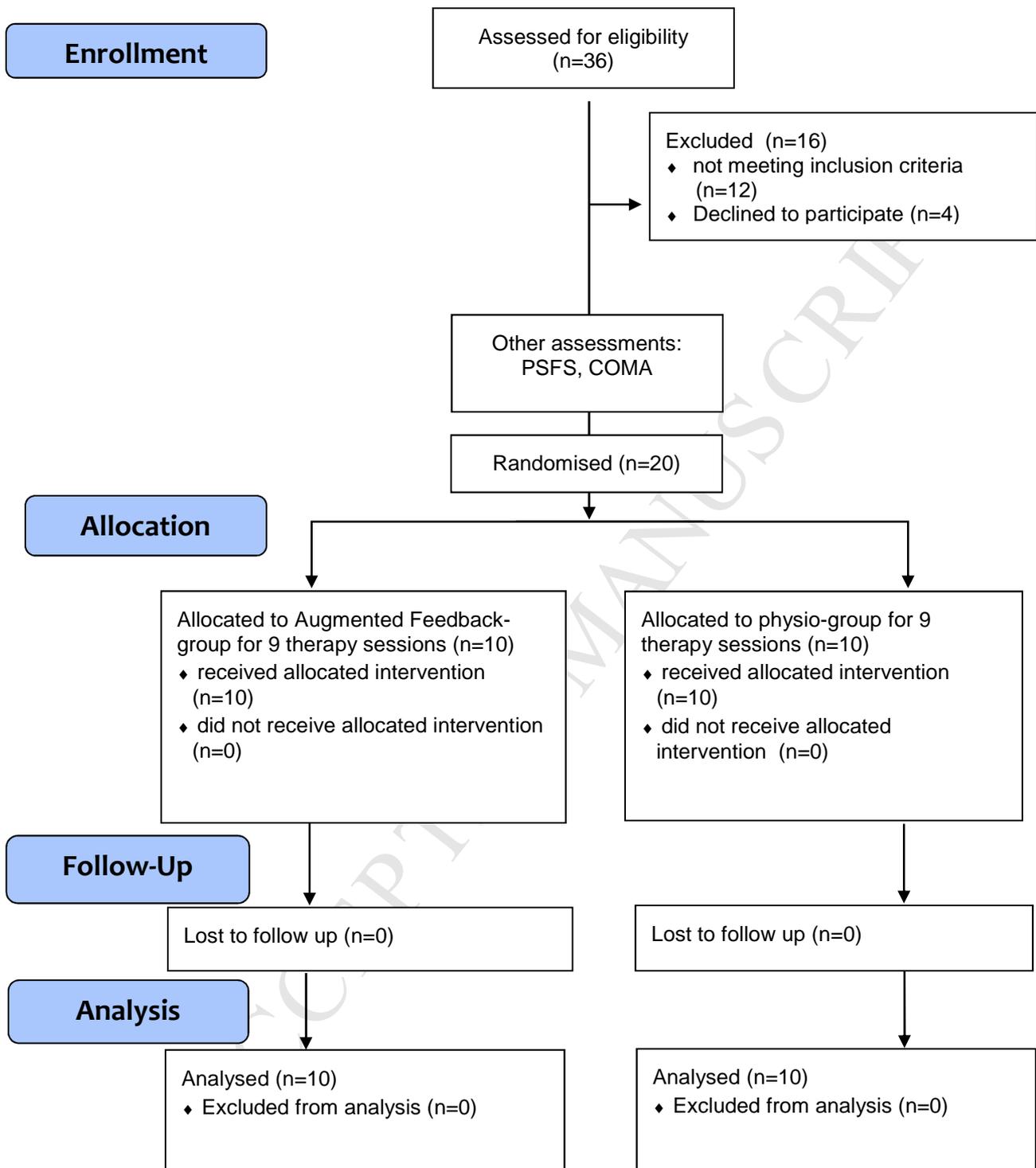


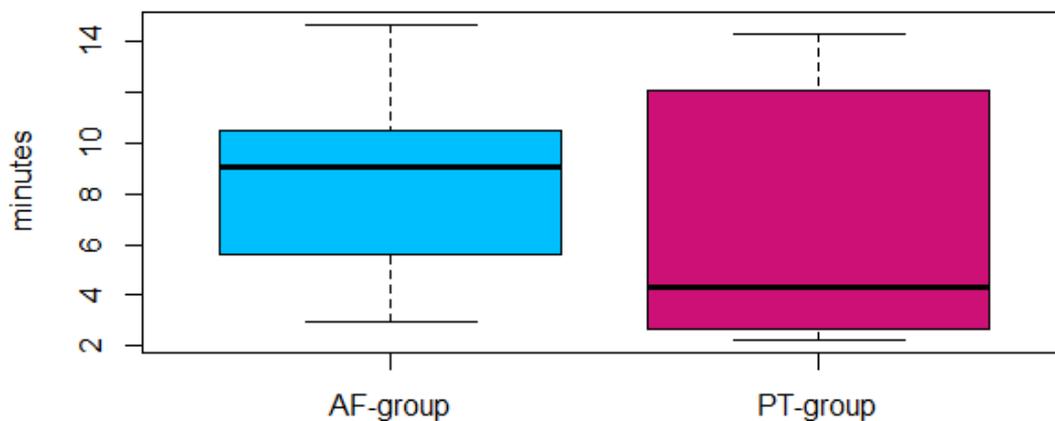
Figure 3: Study flow

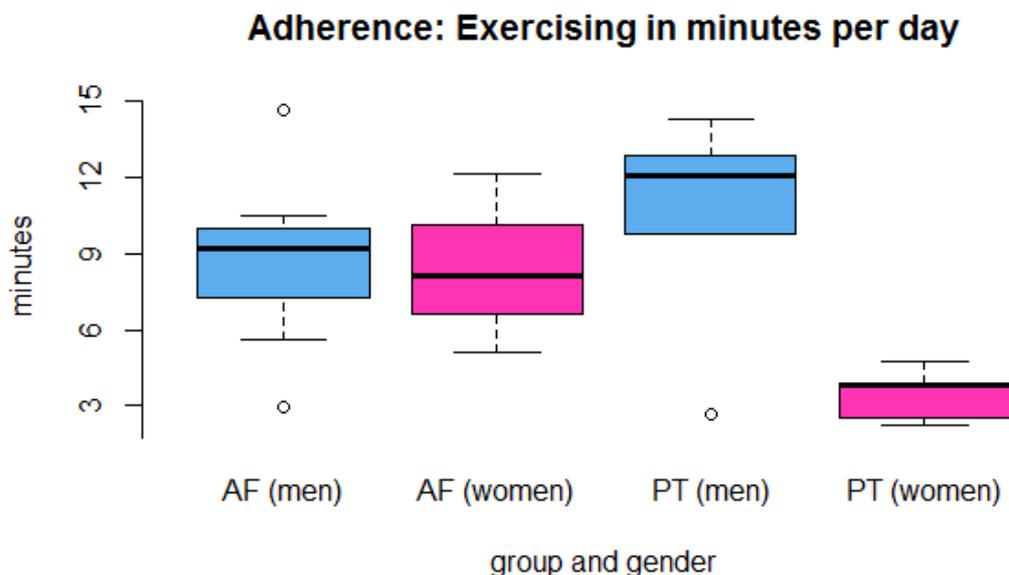
**Table 2: Baseline measures compared between groups**

n= 20		All subjects	AF group	PT group	p-value
ODI [%] (Med., IQR) <sup>b</sup>		16 (10.5)	15 (5.5)	16 (13)	p= 0.52
MCI (Modus, rel. frequency) <sup>c</sup>	2-3 points	11 (55%)	4 (20%)	7 (35%)	p= 0.56
	4-5 points	9 (45%)	6 (30%)	3 (15%)	
PSFS (Med., IQR) <sup>b</sup>	Activity 1	6 (3.25)	5.5 (1,75)	6 (3.75)	p= 0.79
	Activity 2	5 (2.25)	5 (2.75)	5 (1)	p= 0.94
	Activity 3	5 (3)	6 (2)	5 (3)	p= 0.36

n: subjects; AF: Augmented Feedback; PT: conventional physiotherapy; Med: Median; IQR: Interquartile range; rel. frequency: relative frequency; ODI: Oswestry Disability Index; MCI: movement control impairment tests; PSFS: Patient Specific Functional Scale; <sup>b</sup> Wilcoxon rank sum test; <sup>c</sup> X<sup>2</sup> test; for analysis alpha was set at  $\alpha = 0.05$ .

### Self-assessed adherence in minutes per day

**Figure 4: Mean home exercise duration of each group**



**Figure 5: Mean exercise time a day by gender and group**

**Table 3: change of ODI, MCI, PSFS pre- to post-intervention**

n= 20	Baseline (t1)	Post intervention (t2)	p-value
ODI [%] (Med., IQR) <sup>b</sup>	16 (10.5)	7 (8.5)	p= 0.0002
MCI (Mode, rel. frequency) <sup>c</sup>			p= 0.004
MCI 0-1 points		13 (65%)	
MCI 2-3 points	11 (55%)	5 (25%)	
MCI 4-5 points	9 (45%)	2 (10%)	
PSFS Activity 1 [Pts.] (Med., IQR) <sup>b</sup>	6 (3.25)	2 (2.25)	p= 0.0001
PSFS Activity 2 [Pts.] (Med., IQR) <sup>b</sup>	5 (2.25)	1 (4.25)	p= 0.0014
PSFS Activity 3 [Pts.] (Med., IQR) <sup>b</sup>	5 (3)	1,5 (3)	p= 0.0006

n: subjects; t1: prior to intervention; t2: after the intervention; ODI: Oswestry Disability Index; MCI: movement control impairment Tests; PSFS: Patient Specific Functional Scale; Pts.: Points; Med: Median; IQR: Interquartile range; rel. frequency: relative frequency; <sup>b</sup> Wilcoxon rank sum Test; <sup>c</sup>  $\chi^2$  Test; for analysis alpha was set at  $\alpha= 0.05$ .

**Table 4: Between group comparison at the end of the intervention****A- & PT Group**

Measure	AF group	PT group	p-value
ODI [%], (Med., IQR) <sup>b</sup>	8 (7)	5 (10.5)	p= 0.91
MCI (Mode, rel. frequency.) <sup>c</sup>			p= 0.55
MCI 0-1 points	5 (25%)	8 (40%)	
MCI 2-3 points	3 (15%)	2 (10%)	
MCI 4-5 points	2 (10%)	0 (0%)	
PSFS Activity 1 [Pts.] (Med, IQR) <sup>b</sup>	2.5 (2.5)	1 (2.75)	p= 0.32
PSFS Activity 2 [Pts.] (Med, IQR) <sup>b</sup>	1.5 (4.25)	1 (3.25)	p= 0.97
PSFS Activity 3 [Pts.] (Med, IQR) <sup>b</sup>	3 (3)	1 (2)	p= 0.56

AF: Augmented Feedback; PT: conventional physiotherapy; ODI: Oswestry Disability Index;

Med: Median; IQR: Interquartile range; MCI: movement control impairment tests; rel.

frequency: relative frequency; Patient Specific Functional Scale; Pts.: points; <sup>b</sup> Wilcoxon rank

sum Test; <sup>c</sup>  $\chi^2$ ; PSFS: for analysis alpha was set at  $\alpha= 0.05$ .

CONFLICT OF INTEREST

All contributing authors confirm, that no conflict of interest exists that may have affected the outcome of the study.

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RESEARCH HIGHLIGHTS

- Augmented Feedback might be an alternative training form for home exercising and exercises undertaking during physiotherapy in low back pain patients
- There is a tendency for a longer home exercise duration with Augmented Feedback
- Women might particularly benefit from an Augmented Feedback therapy

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