

The use of pixformance for an MS-Patient and the effect on his balance and walking ability

Abstract

Background: Limitations in mobility and balance affect patients with Multiple sclerosis (MS). The purpose of this study is to evaluate whether training with Pixformance can offer a therapy alternative.

Objective: The aim of this study is to evaluate, if the application of Pixformance and the corresponding homework program have a positive effect on the walking ability of a patient with MS and whether the application have a further positive effect on the balance ability and quality of life in this patient.

Method: A single case study over a period of 16 weeks with two four-week training phases alternating with two four-week exercise breaks was carried out. In the training phases, the study participant conducted a training course with Pixformance and the corresponding homework program. Exercise breaks served as control phases. Five test methods were used to measure the impact of the program.

Results: The walking ability improved during the two assessment periods, the Timed Up and Go Test and the 10 Meter Walk Test. However, these two tests did not show any correlation between the performance of the study participant, training phases and exercise breaks. The participant achieved an increase in his balance ability after the two training phases in the Berg Balance Scale and in the Functional Reach Test. Even after the two exercise breaks, the positive effect was still obvious. Further, the MSQOL-54 questionnaire showed that mental and physical health increased.

Conclusion: An improvement in walking and balance ability as well as an improvement in quality of life could be shown in this patient. An individual training supported by Pixformance has a positive effect on the health and mental state of this MS patient.

Keywords: pixformance, multiple sclerosis, physical therapy, walking, balance, single case study

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Introduction

Many patients with multiple sclerosis (MS) suffer from limited mobility. As the disease progresses, approximately 70% of all those affected are restricted in their ability to walk.¹ This means losing their independence, which has an impact on participation in social life and quality of life. To strengthen patients' resources and maintain their mobility, it is important to provide them with appropriate training. The present work describes a case study with the training device "Pixformance". It acts as a personal trainer, corrects the movements of the exerciser, and thereby gives direct feedback. Due to the limited mobility of many MS patients, such a device which can be used for independent trainings could contribute to physical well-being.

Pixformance was developed in 2011 by a Berlin start-up company and awarded the FIBO Innovation Award in 2014.² The training device is a large screen that acts as a personal trainer. The Pixformance website can be used to create a workout plan from a pool of 93 exercises. Rhythm, repetition number and number of series are settings which can be individually specified. The training program can be started with the help of a QR code. The exercises are performed correctly and in the right pace by a person on the screen. Now the user can imitate the exercise. An integrated camera records the movement of the exerciser and displays it on the screen. This enables the exercising person to correct himself; additional suggestions to correct the movement

execution are communicated through text fields and symbols. A direct feedback is presented after each exercise regarding repetitions, pace, range of motion and precision. The results of training can be stored on a web-based platform on which the user can follow his training level.

First evidence on the effectiveness of Pixformance was shown in 2014 by the Institute for Prevention and Aftercare in Cologne, which demonstrated with 57 women that training with Pixformance has a positive effect on body weight, body fat, flexibility, coordination skills, strength and endurance.³ Likewise, a case study of a neurological patient shows improvements in the strength of the torso and legs as well as of the balance ability after four weeks of training.⁴

Research question

Primary question: Does the application of Pixformance and the corresponding homework program have a positive effect on the walking ability of a MS patient?

Secondary question: Does the application of Pixformance and the corresponding homework program have a further positive effect on the balance ability and the quality of life of an MS patient?

Materials and methods

An individual case study in the A-B-A-B design was carried out.⁵ The study duration was 16 weeks in which two 4-week A-phases and

B-phases each took place. The intervention with Pixformance with the accompanying homework program were conducted during the A phases (weeks 1-4 and 9-12), while the exercise breaks took place during the B phases (weeks 5-8 and 9-12). The B-phases served as control phases to determine if and how long the intervention is effective.

Five assessments to measure walking ability, balance ability and quality of life were performed before and after each phase. Each time the individual tests were performed in identical order; the duration of the entire test battery lasted approximately one hour.

Before the study, a mean value for each test was determined at three different days, to serve as baseline values.

The study participant was recruited with the cooperation of Fresenius University of Applied Sciences with Falkenstein, hospital for neurological rehabilitation. His right side is clearly affected and reacts according to subjective evaluation to weather changes, especially to heat. The physiotherapy and ergo therapy, which took place two times per week outside the study, was continued as a basic therapy. Besides this, no additional treatment for him was applied. The medication was not changed.

Intervention

The selected exercises had the goal to strengthen the leg and torso muscles and to train the balance. The good stability in the torso is intended to result into a safe and efficient gait.⁶ To achieve this, the exercises Single Leg Balance, Squat, Standing Bicep Curl Alt-Arm as well as Overhead Pull Alternating Arms were chosen from

the Pixformance program. The exercises are challenging and can be performed well by the study participant in a standing position. To minimize the risk of possible relapses due to stress factors, the exercises are not too demanding. Even though studies have shown that a short-term stressor does not have a negative effect on the disease, chronic psychosocial stressors are a relapsing factor.⁷

During the two training phases, the participants performed the exercises in up to three daily sets of 10 repetitions each.

The participant trained alone at home during the training phases to achieve a greater training effect. A training diary enabled the participant to report every day and to give feedback on the training, his daily condition and whether or not a connection with the weather was recognizable.

Five assessments were used (Tab. 1): walking ability was measured with the 10 Meter Walking Test (10-MWT) and the Timed Up and Go Test (TUG).^{8,9}

Balance ability was assessed using the Berg Balance Scale (BBS) and the Functional Reach Test (FRT); the MSQOL-54 questionnaire was used to evaluate the quality of life.¹⁰⁻¹²

Results

Since this is a single case study, the analysis cannot provide final results, however it delivers evidence for future research on this topic.

The results of the TUG are shown in Figure 1, including a trend line. At the beginning of the study (measurement 1), the required time of the study participant is 41.96s.

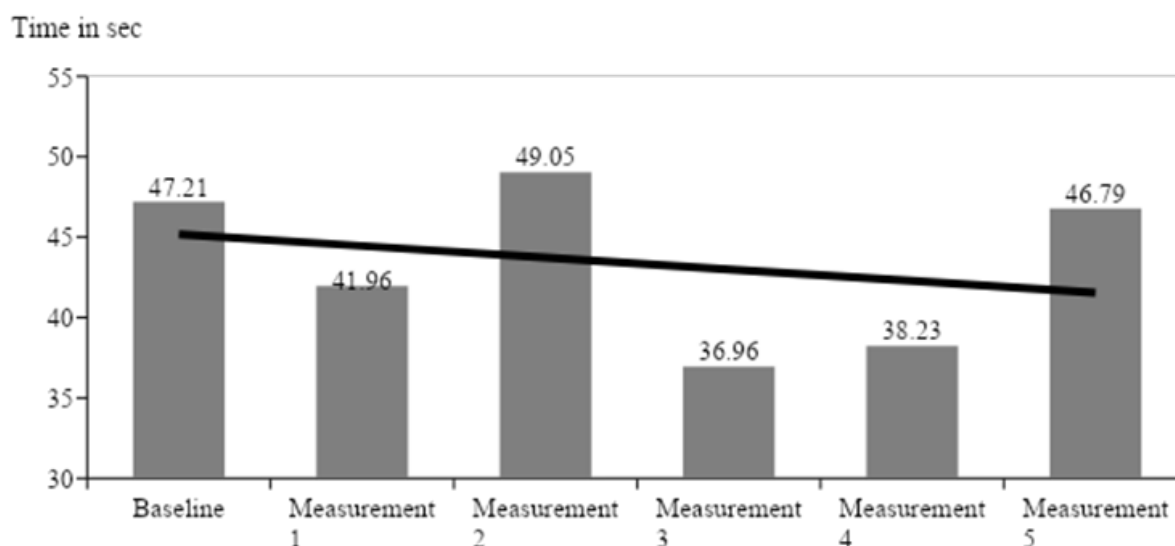


Figure 1 Results of the timed Up and Go test.

After the first four-week training (measurement 2), the value rises up to 49.05s. The study participant therefore needs more time for the test after the first training than before. After the first exercise break (measurement 3) he achieves the fastest time during the entire study

(36.96s). After the second four-week training period (measurement 4), the required time increases to 38.23s. After the second four-week exercise break (measurement 5), the value increases to 46.79s. The slope of the trend line is negative, on average, the time required for

the test decreases, the performance of the study participant shows a positive course. However, the study did not reveal a big difference regarding walking ability of the patient during training phases and during exercise breaks.

The results of the 10 MWT are describes in the following: After the first four-week training phase, the required time increases from 47.02s (measurement 1) to 56.01s (measurement 2). Therefore, the study participant needs more time than before. After the first four-week break (measurement 3), the value reached drops to 40.65s, about 15s (27.5%) less than after the first training period, which is the shortest time during the study. After the second training phase (measurement 4), the value rises to 44.17s; this value is approximately maintained after the second training break (measurement 5). The slope of the trend line is negative, indicating a positive effect.

In the BBS the balance ability is divided into a static and a dynamic component. This is also illustrated in Figure 2. The abscissa in the bar graph shows the baseline and the following five measurements. The ordinate shows the sum of the achieved scores in both components.

The measured values after four weeks of training (measurements 2 and 4) show a clear increase in the static balance ability point values

(dark grey bars) of about 4-5 points in comparison to each previous measurement (measurements 1 and 3). This indicates that the training program has a positive influence on the study participants' static balance ability after four weeks of training. The measured values after four weeks of exercise break (measurements 3 and 5) show a reduction by 2-4 points. This is another indication of the positive effect of the training program, as the positive effect that occurs after the training phases is absent here. The test scores after the two training breaks do not decrease to the original level of performance but maintain a certain level. Overall, the training has a corresponding positive effect.

The light grey bars (Figure 2) show the course of the dynamic balance ability. After the first four-week training, the achieved score increases from 14 to 17 points (measurements 1 and 2). It remains at this level during the first exercise break (measurement 3). After the second training phase the achieved value increases to 18 points (measurement 4). Likewise, an increase by another point to 19 points (measurement 5) can be seen after the second exercise break.

It is worth pointing out that the scores never decrease during the entire study compared to each previous measurement, including the four-week exercise breaks. This shows a clear positive effect on the dynamic balance ability.

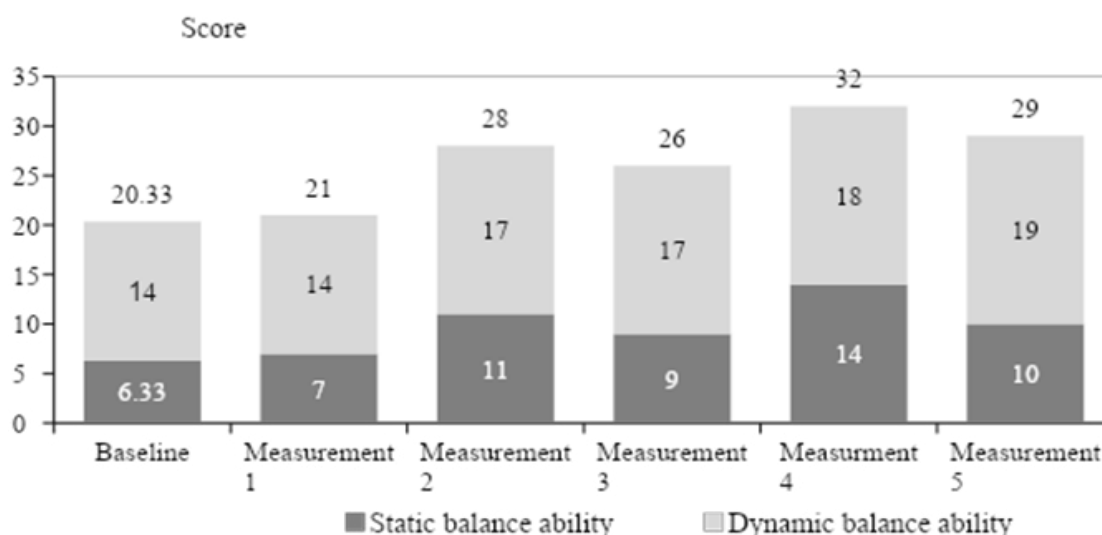


Figure 2 Results of the berg balance scale.

In the total score of dynamic and static balance ability, the common value increases from 21 to 28 points after the first four-week training period (measurements 1 and 2). After the first exercise break, the value drops to 26 points (measurement 3), which can be explained by the decrease in static balance ability. The accomplished effect of training is also recognizable after a four-week break. After the second training phase, the value increases to 32 points (measurement 4) and reaches its maximum. After the second exercise break, the score drops to 29 points (measurement 5), again explainable with the static balance ability. Altogether, there was an improvement in the balance ability, which is still visible after two exercise breaks.

After the first four-week training phase, the achieved value in the FRT increases from 15cm (measurement 1) to 17cm (measurement 2). After the first exercise break, this value remains at 17cm (measurement 3). After the second training period the value reaches its maximum and increases to 20cm (measurement 4). A greater improvement in range is achieved compare to the first training phase. This improvement does not continue after the second break but drops to 16cm (measurement 5).

An absolute increase in balance ability is visible. Even though the last value (measurement 5) decreases, an improvement is still achieved compared to the beginning of the study.

The measurement of physical and mental health with the MSQOL-54 questionnaire, which was developed for MS patients, calculates two primary scores. On the one side the physical - and the mental health, as well as 14 subscales. Figure 3 displays a bar chart with the achieved scores in percentages. At the beginning of the study, physical health (dark grey bars) is 37.2%. The value increases to 44.2% after the first training period and drops back to 39.9% after the first exercise break. After the second training phase, the value increases to 57.6% and reaches its maximum. Therefore, the value is 13.4 percentage points higher than the score after the first training phase. After the second exercise break, the value drops to 52.6%. This is the second highest value. Physical health therefore shows a positive development during the study.

Mental health (light grey bars) is about 30-40 percentage points higher than physical health throughout the study. At the beginning of the study, the value is 79.4% and rises to 88.0% after the first training phase. After the first exercise break, the value decreases to 82.8%. After the second training phase, the value increases to 84.2%. After the second exercise break, the value rises to 88.3% and reaches its

maximum. The general increase of the scores therefore indicates a possible positive effect of the training on the mental health.

The table of the 14 subscales [Table 1] is interpreted as follows: regarding the “changes in the state of health” the value increases from 50 to 75% after the first training phase (measurement 2) and that it remains at this level until the end of the study.

In the case of “pain behavior”, the value is 86.7% (measurement 1) and increases to 100% (measurement 2) after the first training period, where it stays until the end of the study.

As can be seen by the low percentages (5-15%) of physical health, the study participant rates his physical health rather low. Since the values increase until the end of the study, the training shows a positive effect on this aspect of the patient.

Regarding the point “constraints due to physical issues”, the values of the first three measurements are 0%. After the second training phase (measurement 4) the value increases to 100% and stays there after the second exercise break (measurement 5).

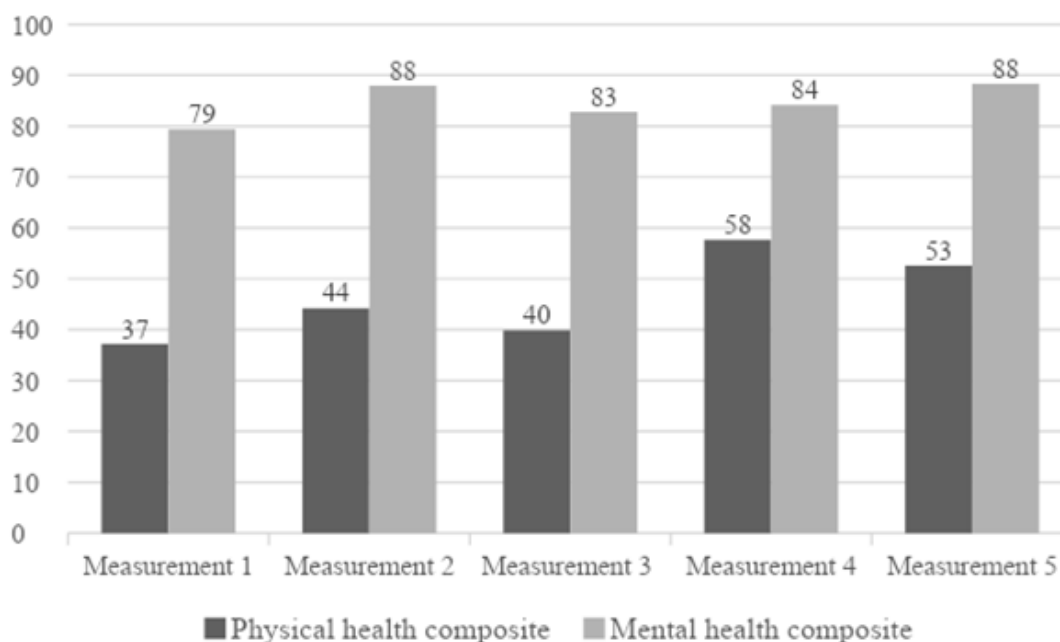


Figure 3 Results of the MSQOL-54 questionnaire (Physical and mental health composite).

The value of “emotional well-being” at the beginning of the study is 88% (measurement 1). This value increases to 92% each time after the two four-week training phases (measurement 2 and 4) and decreases to 88% after the exercise breaks (measurement 3 and measurement 5). The values for “limitations due to emotional issues” are 100% throughout the study. The patient therefore estimates his emotional well-being high and does not perceive any restriction in this.

The development of social function has a positive course. At the beginning of the study, the value is 41.7% (measurement 1). After the first training phase (measurement 2) the value increases to 66.7%.

After the first exercise break (measurement 3) the value drops to 50%. After the second training phase (measurement 4), the value continues to increase to 75% and stays at this level, even after the second exercise break (measurement 5).

At the beginning of the study, the “overall quality of life” is 41.7% (measurement 1) and increases to 66.7% after the first training phase (measurement 2). After the first exercise break, the value increases to 70% (measurement 3). Following the second training phase the value increases to 80% (measurement 4) and drops to 75% after the second exercise break (measurement 5). Except for the last value, the overall quality of life of the study participant increases constantly.

Table 1 Results of the 14 subscales of the MSQOL-54 questionnaire

Criteria	Measurement 1	Measurement 2	Measurement 3	Measurement 4	Measurement 5
1. Change in health	50	75	75	75	75
2. Cognitive function	70	80	56.25	75	80
3. Emotional well-being	88	92	88	92	88
4. Energy	60	60	65	65	40
5. Health distress	85	95	87.5	87.5	95
6. Health perceptions	10	20	10	10	0
7. Overall quality of life	41.7	66.65	70	80	75
8. Pain	86.67	100	100	100	100
9. Physical health	5	5	10	15	15
10. Role limitations due to emotional problems	100	100	100	100	100
11. Role limitations due to physical problems	0	0	0	100	100
12. Satisfaction with sexual function	50	50	50	50	50
13. Sexual function	41.7	41.7	33.3	49.99	33.3
14. Social function	41.67	66.67	50	75	75

With regards to the point “health perception”, which fluctuates between 0-20% during the study, the study participant generally assesses his health status as very low. No connection between training and exercise break is visible in this case.

The area “health burden”, which varies between 85-95% during the study, shows that the study participant does not feel much burdened by his illness. A possible positive effect in this point by the training can be assumed because the percentage values increase after the two training phases and that the positive effect is even recognizable after the exercise breaks.

The study participant estimates his “energy levels” at the beginning of the study at 60% (measurement 1), which remains at this level even after the first training phase (measurement 2). After the first exercise break and the second training phase the value increases to 65% (measurements 3 and 4). After the second exercise break, the value drops to 40% (measurement 5). Except for the last value a positive tendency for the energy is visible.

The overall value for “cognitive function” varies between 60-80%. After the first training phase the percentage value increases from 70 to 80% (measurement 1 and 2). After the first exercise break, the value drops to 56.3% (measurement 3) and subsequently increases again to 75% (measurement 4) after the second training phase. After the second break, the value increases to 80% (measurement 5). A positive effect on cognitive function is therefore visible.

The aspect “sexual function” fluctuates around 35-50% during the study. No correlation between training phases and exercise breaks is detectable. “sexual satisfaction” remains constant at 50% throughout the study; no effect of the training is visible.

Discussion

In summary, it can be seen from this case study that the training with Pixformance and the associated homework program improves walking ability. However, no correlation can be seen between the performance of the study participant and the training phases and exercise breaks. Similar developments of the results of the TUG and 10 MWT suggest that the performance throughout the various days of the measurement differed. Stress and the fitness of the day of MS patients can affect performance and may have influenced outcomes.¹³ In order to obtain clearer results, the study would have to be carried out over a longer period of time with more measurements and subjects.

Regarding balance ability, a clear positive effect of training can be seen. The results of the BBS and the FRT have improved after the two training phases. The decrease or stagnation of the results after the exercise breaks gives additional proof of a positive effect as the positive trend which has occurred after the training phases is eliminated. The results never fall back to the initial value after the exercise breaks, which show a carry-over effect. It is striking that the dynamic balance ability improves more than the static balance ability. The reason for this could be attributed to the training, since most exercises were of dynamic nature.

A positive effect of the training can also be detected on the quality of life. Mental and physical health of the participant increased after the two training phases and this effect is still noticeable after four weeks break. The subjective feeling coincides with the results of the tests, which perform an objective measurement of physical health.

Regular exercise also seems to have a positive impact on mental health. It increases the oxygen content in the body. As a result, muscles and brain are better supplied with oxygen and thought processes are improved.¹⁴ Further, physical activity can reduce depressive symptoms and increase self-esteem.¹⁵

The results of the case study can only be applied to this case study and cannot be generalized. They yield no scientific proof since the sample for this research included only one person.¹⁶ The knowledge gained can only be transferred to comparable persons and groups.

The personal support can lead to possible distortions of the results. The results of MSQOL-54 show that the study participant rated his mental health better during the study than before. This could be attributed to the better mental well-being due to the support.

Since the training with Pixformance contains mainly exercises that have to be completed while standing, there were some problems in the execution by the participant, as he was not stable enough in a standing position. The exercises often had to be restarted. It was not possible to perform the exercises in a wheelchair since the training device recognizes the exerciser only when standing and not in a sitting position. An improvement suggestion for Pixformance would be to allow for performance of exercises that strengthen the upper limb and the trunk also in a sitting position.

Nevertheless, the training device is well-suited for less-affected patients and can be integrated into a therapy routine. A virtual trainer would provide many advantages for physiotherapists as well. Several patients could be supervised simultaneously, and patients receive direct feedback on their movement without the presence of a therapist. In addition, direct data collection makes it easier for the therapist to evaluate the patient's training state.

Additionally, the factor demographic change provides increasing importance to create training devices that enable patients to train effectively on their own. As the population ages, there will be more need for physiotherapists, and the therapeutic offer may no longer be able to meet patients' needs.¹⁷

Assessments such as the 6-MWT, the Tinetti Test or the Dynamic Gait Index could have been used to better assess the walking ability. However, they were too difficult for the patient's level of performance.

Conclusion

The positive outcome in terms of performance and mental health of the study participant during the study suggests that regular training can be beneficial. With the support by the Pixformance device, in conjunction with a customized homework program, this effect can be maintained, if not enhanced. Visual support during training seems to be an advantage, as it ensures that the exercises are performed correctly.

Due to the demographic development in Germany and the resulting lower availability of healthcare professionals, training models that are designed for the independent implementation by the

patient will become increasingly important in the future. Regarding the limitations of the study participant and other patients, the range of exercises would need to be further developed to offer more exercises to be performed while sitting. The operation of the device is so well laid out so that it is easy to handle.

Considering the weaknesses of such a format, this case study suggests that Pixformance-assisted exercise can have a positive effect on the health and mental condition of an MS patient. Further research is however necessary.

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Ethics committees

Based on the results of an ethical questionnaire, the opinion of the ethic committee of the university Fresenius was not needed.

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Conflicts of interest

The authors declare no conflicts of interest (declarations of interest: none).

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