

Behavioral responses to a combined music therapy and physiotherapy intervention in children with severely restricted neurological function

Abstract

Background: Children with neurological impairment receive multimodal treatment during clinical inpatient stays. There is a general lack of empirical evidence on the combination of different therapy modalities.

Methods: This study investigates music therapy assisted physiotherapy in the form of individually live performed music by a qualified music therapist to support a physiotherapy intervention and improve the patient's behavior. We examined the behavioral responses of children with neurological impairment during music therapy assisted physiotherapy with the COMFORT Behavior Scale (CBS), an instrument that assesses the levels of sedation in children. The parameters alertness, calmness, crying, physical movement, muscle tone and facial tension were investigated in 17 children with neurological diseases during their hospitalized neurological early rehabilitation before, during and after the physiotherapy sessions with and without music therapy.

Results: We observed significantly lower values of the total CBS scores during (mean differences -5.31 ; 95% confidence interval (CI) $4.67-5.94$) and after the combined intervention (mean differences -7.73 ; 95% CI $7.15-8.31$) than before. Conversely, we found an increasing total CBS score of 4.78 (95% CI $4.07-5.49$) between baseline measurement and measurement during physiotherapy without music therapy. But we saw a decrease of the total CBS score of 4.52 between during and after the session, so that we had similar values before and after the sessions (mean difference 0.26 , 95% CL $-0.49-1.00$).

Conclusion: Overall, our findings suggest that music therapy is beneficial for neurologically impaired children during physiotherapy interventions with positive effects on their behavior.

Keywords: music therapy, neurological diseases, pediatrics, behavioral state, physiotherapy, hospitalized children, neurological early rehabilitation

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Introduction

Patients with acute brain injuries are usually treated directly on an early rehabilitation ward because consequences can worsen rapidly without treatment [1], [2]. In addition to medical care, the patients receive various therapies during hospitalization, such as speech therapy, occupational therapy, and physiotherapy [1].

Listening to music influences the mood and arousal, which can improve performance on a variety of cognitive abilities. In the last years, the number of research findings on the use of music or music therapy in the clinical context with various diseases has increased significantly, including a wide range of results in several specialties [3]. Non-pharmacological methods such as music therapy are increasingly used in psychiatry and somatic medicine as adjuvant therapies [4] and research in this field uncovers music's high potential as a tool for rehabilitation [5]. Physiotherapy combined with music therapy benefits pediatric patients with lower extremity burns and provides a safe method to improve pain, range of motion, and gait parameters [6]. Also, physiotherapy combined with music is more effective in people with cerebral palsy because it improves motor function and facilitates voluntary movements [7], [8], [9]. Music therapy and meditation are more beneficial than traditional physiotherapy alone, and music therapy turns out to be the better intervention among them [10], [11]. A study with infants with Erb's palsy investigated the amount of crying during physiotherapy with and without music and showed that the amount of crying decreased when music was played during therapy [12]. Four to 33 month old infants at risk for developmental disabilities may also benefit from the use of music during physiotherapy to reduce crying [13].

Several studies have examined the behavioral and physiological responses of infants and children, when music is played. Various studies have shown that music can have a motivating effect on physical activity [14], [15], [16]. While research publications on the effectiveness of music in medical and therapeutic interventions are increasing [17], [18], [19], there is still a lack of studies on the effectiveness of music therapy combined with applications such as physiotherapy. The effects of live performed music therapy by a qualified music therapist during physiotherapy in terms of behavior needs to be inspected [10].

The aim of this study was to examine the effects on children's behavioral responses when live music therapy is played in physiotherapy interventions. We hypothesized that music therapy stabilizes the behavioral state of children with severely restricted neurological function during physiotherapy treatments.

Methods

2.1 Research design

The results presented here were collected as part of a prospective clinical trial. A cross-over design was used for the data collection. For this paper, we analyzed the behavioral states of 17 patients before, during and after physiotherapy sessions with and without live played music therapy by a qualified music therapist at the phase B rehabilitation at Clemens Hospital Muenster. It is a ward for pediatric patients who require invasive procedures and intensive monitoring. Therefore, we used the COMFORT Behavior Scale (CBS), a rating scale for measuring distress in pediatric intensive care patients. In addition, vital signs data such as heart rate, respiratory rate and oxygen saturation were saved on the monitor 15 minutes before, during and 15 minutes after each therapy session [10].

2.2 Participants

Children with early-stage neurological diseases who were hospitalized at the phase B rehabilitation at Clemens Hospital Muenster between September 2020 and June 2021 were eligible for the study. Patients without monitoring during the physiotherapy sessions or in a palliative care were excluded from the study. During the first week of hospitalization, informed consent was obtained by the parents. The local ethics committee of Aerztekammer Westfalen-Lippe and Westfaelische Wilhelms-University approved (2020-672-f-S) and the DRKS registered (DRKS00025850) the study.

2.3 Sample size and sampling methods

The calculation of the sample size with a population size of 20 patients, a margin error of 10% and a 95% confidence level indicated that at least 17 patients should be included. We used the probability sampling method in the form of a simple random sampling. The children with early-stage neurological diseases up to the age of 18 had to be treated at the phase B rehabilitation at Clemens Hospital Muenster.

2.4 Intervention

Neurological rehabilitation is focused on an activating care and therapeutic support. Elements of the integration serve the promotion of body awareness, mobilization and relearning of body control. Motor activities, posture and movement patterns are developed in the therapies. Correspondingly, as progress is made in the individual wake-up phases, the patient becomes increasingly active. The therapist helps the patient to achieve independence as far as it is possible.

Neurological treatment techniques and concepts of Vojta Therapy [20], the Bobath concept [21] and elements of respiratory therapy [22] were used during physiotherapy interventions which were performed between four and

six times a week in clinically stable patients starting directly after admission to the hospital. Every second session was conducted with live played music by a qualified music therapist. The physiotherapy was carried out with the same program, regardless of whether live performed music therapy was included or not.

Music therapy was performed by a qualified music therapist during every second physiotherapy intervention starting from the second week of hospitalization. The timing of each therapy session was coordinated by the physiotherapist, music therapist, nursing staff and parents. Music therapy was modified based on the patient's ability to react to the current moment. According to breathing and heart rates of the patient the tempo of the sounds was adjusted. During breaks in physiotherapy exercises, deep and slow tones were played to create a calm atmosphere. During exercises that required a lot of strength from the patient, the music therapist played upwards moved melodies with a faster tempo. As exercises became easier for the patient and less effort was required, the melody returned to deeper tones. The music supported the physiotherapy exercises and created a calm atmosphere between the exercises.

Musical parameters such as tempo and rhythm were altered according to changes in a patient's alertness or arousal, incorporating salient physiotherapy content [23], because the effect of music seems to be greatest when used alongside self-paced exercises. When music is played for its motivating qualities, music's positive impact on both mental status and performance is amplified [15]. The music therapist played the instrument sansula and sang melodies with a few musical notes. The tempo and the sound of the music was adapted on the children's reactions. The sansula is a development of the instrument kalimba which has its origins in Southern Africa. It is a metal-tongued instrument, played by plucking the tines. The vibrations of the sansula are first stored in a wooden block and from there transmitted to a resonating membrane. Due to the tuning, the instrument has a soft sound rich in overtones. We chose the sansula instrument because several studies with preterm infants and their parents have already shown that the sounds of the sansula have a relaxing effect and positive effects on the vital signs heart rate, respiratory rate, and oxygen saturation [17], [19] as well as their well-being [24], [25], [26]. The music therapy was adapted and carried out individually for each child and each situation based on the physiotherapy treatment.

Detailed information of each therapy session including the children's behavioral states according to the CBS and vital signs before, during and after the session were documented on a form and analysed.

2.5 COMFORT Behavior Scale (CBS)

The CBS was developed in pediatric intensive care to evaluate the patient's distress. It is an unobtrusive method of measuring distress of infants, children, and adolescence, based on observable behavior. It is validated

in several languages and includes the six scale items alertness, calmness, crying, physical movement, facial tension and muscle tone scored in closed response categories. Each item can be scored with values ranging between one and five based upon the behaviors exhibited by the patient (Table 1). The total score can range from six to thirty. The indication for intervention is a score ≥ 17 [27], [28].

Alertness is scored based on the child's response to ambient stimulation in the environment including responses to sounds, movement and light. Calmness and agitation rate the child's level of emotional arousal and anxiety. Crying is rated in non-ventilated children. The emphasis is on the sound and the behavior of the child rather than on the presence of tears. Physical movement rates frequency and intensity of movements related to distress. Only distress related movements should be scored, not a playing child or a child moving its head to look at something. Facial tension assesses tone and tension of facial muscles. The standard of comparison is a child who is awake and alert. Muscle tone is assessed in relation to normal muscle tone in a patient who is awake and alert. The rating is based upon the patient's responses to rapid and slow flexion and extension of a non-instrumented arm or leg. If arms and legs are not available, it will suffice to lift a wrist or ankle. This rating is the only one that requires active intervention by the rater and is performed after the two-minute observation period.

2.6 Bias

Each child's therapeutic process was documented in a standardized form by a trained music therapist and a trained physiotherapist. To maintain blinding, no notes about the therapy sessions were entered into the patients' medical records.

2.7 Statistical analysis

Behavioral responses of each child were observed before, during and after therapy sessions and reported using the CBS with means and 95% confidence intervals (CI). We performed paired t-tests to compare the values of each area of behavior before, during and after physiotherapy with or without music therapy. We employed IBM SPSS Statistics 27 (IBM, Chicago, IL, USA) for all statistical calculations. The alpha-level was set at $p < .05$.

Results

3.1 Patients

Seventeen children with neurological diseases who were treated at the Clemens Hospital Münster between September 2020 and June 2021 were included in the study. The medical treatment was carried out according to the specifications of phase B rehabilitation. All children,

Table 1: Six subcategories of the COMFORT Behavior Scale (CBS) with the five rating options

Instrument item	Rating options	Child's response
Alertness	1	Deeply asleep
	2	Lightly Asleep
	3	Drowsy
	4	Awake and alert
	5	Awake and hyperalert
Calmness	1	Calm
	2	Slightly anxious
	3	Anxious
	4	Very anxious
	5	Panicky
Crying	1	Quiet breathing, no crying sounds
	2	Occasional sobbing or moaning
	3	Whining (monotonous sound)
	4	Crying
	5	Screaming or shrieking
Physical movement	1	No movement
	2	Occasional slight movement
	3	Frequent, small movements
	4	Vigorous movement limited to extremities
	5	Vigorous movement including torso and head
Facial tension	1	Facial muscles totally relaxed
	2	Normal facial tone
	3	Tension evident in some facial muscles
	4	Tension evident throughout facial muscles
	5	Facial muscles contorted and grimacing
Muscle tone	1	Muscles totally relaxed, no muscle tone
	2	Reduced muscle tone; less resistance than normal
	3	Normal muscle tone
	4	Increased muscle tone and flexion of fingers and toes
	5	Extreme muscle rigidity and flexion of fingers and toes

3 girls and 14 boys, completed the study. Seven children were excluded. Nine children (53%) had German as their native language. The children included in the study had acquired brain injuries from accidents (24%), viral infections (12%), brain attacks due to previous illnesses (29%) or congenital brain injuries as preterm infant or ill newborn (35%) (Figure 1). The demographic characteristics and the mean Barthel Index Score values for early rehabilitation at admission and at discharge of the included patients are presented in Table 2.

At admission to hospital, all patients had severe communication disorders (88% at discharge), 82% swallowing disorders (76% at discharge), 82% were fed by PEG/PEJ (65% at discharge), and 71% had a condition for intensive medical care (53% at discharge). The total Barthel Index Scores for each included patient at admission and at discharge and the scores of the subcategories of Barthel Index are presented in Table S1 in Attachment 1.

The Barthel Index is a method for the systematic recording of basic everyday functions. Ten different areas of activity are evaluated with points. Each item is scored based on whether the person can perform a task or activity independently, with assistance, or completely dependently. The maximum achievable score is 100 points.

3.2 Therapy sessions

Two-hundred and fifty-six (N=256) physiotherapy sessions were conducted at the phase B rehabilitation at Clemens Hospital Muenster, 128 with music therapy and 128 without music therapy. The same number of each kind of session, physiotherapy, and combined physiotherapy with music therapy, was conducted with each child twice weekly. The mean duration of one physiotherapy session was 44 minutes (range 21 to 71 minutes).

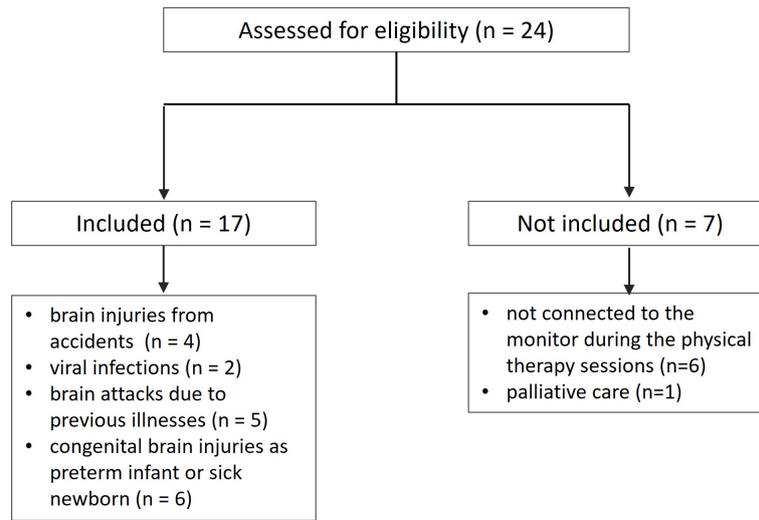
3.3 Analyses of behavioral state during physiotherapy sessions with and without music therapy

We saw a decrease of the total score between before and during physiotherapy with live played music of 5.31 (95% CI 4.67–5.94). After physiotherapy sessions with music therapy, we found a further decrease of 2.42, so we observed an overall decrease from before to after therapy of 7.73 (95% CI 7.15–8.31).

We found an increasing total score of 4.78 (95% CI 4.07–5.49) between baseline measurement and mea-

Table 2: Clinical characteristics of participants

	Patients (n=17)
Male, n (%)	14 (82%)
Age (month), mean (range)	39.75 (1–134)
Native language	
German	9 (53%)
Other languages	8 (47%)
Physiotherapy sessions (with and without music therapy)	256 (128; 128)
Mean Barthel Index Score for early rehabilitation	
At admission	-148.5
At discharge	-116.2

**Figure 1: Flow chart of the included and not included participants of the study**

surement during therapy when physiotherapy was performed without music therapy. But we saw a decrease of the total score of 4.52 between during and after the therapy session, which shows that the children were back to nearly the same behavioral states after therapy as they were before physiotherapy without music therapy (mean difference 0.26, 95% CL -0.49–1.00). After the physiotherapy with the live played music by a qualified music therapist, the patients were much more relaxed than before the therapy (mean difference -7.73 and p value=0.000) (Table 3, Table 4, Figure 2).

When analyzing the subcategories alertness, calmness, crying, physical movement, facial tension and muscle ton, we saw that all six baseline values had nearly the same score before therapy interventions regardless of whether a treatment was provided with or without music. We found an increased mean during the physiotherapy with music therapy and a decreased mean during the physiotherapy without music therapy in all subcategories (Table 3). After therapy we saw an additional increased mean of the intervention with music therapy and an additional decreased mean of the intervention without music therapy in alertness, calmness, physical movement, facial tension and muscle tone. In crying we found an increased mean when comparing the values during and after physiotherapy without music therapy. The mean differ-

ence with music therapy was 1.83 and without music therapy 0.40 (Table 4).

Discussion

This study provides evidence that live performed music therapy during physiotherapy interventions has beneficial effects on the behavioral state of hospitalized children with early-stage neurological diseases. We found a decrease in the total CBS scores during physiotherapy therapy with music therapy and an increase during physiotherapy therapy without music therapy. We saw an increasing total CBS score between baseline measurement and measurement during physiotherapy without music therapy. But we saw a decrease of the total CBS score between during and after the session, so that we had similar values before and after the physiotherapy sessions without music therapy.

Several studies have shown that music therapy has a stabilizing and relaxing effect, regardless of the patient's age or the severity of the illness [17], [18], [19], [29] and promote brain development [30], pain relief, stress reduction, and memory [31]. Our results are in line with former findings with infants and toddlers with or at risk for developmental disabilities who benefit from the use of music during physiotherapy and reduce crying [13].

Table 3: Subcategories alertness, calmness, crying, physical movement, facial tension and muscle tone and total CBS scores before and during physiotherapy sessions with and without music therapy

Instrument item	Music therapy	N	Mean before therapy (95% CI)	Mean during therapy (95% CI)	Mean difference (95% CI)	P value	Effect size*
Alertness	Yes	128	3.45 (3.30–3.60)	2.62 (2.49–2.76)	0.82 (0.67–0.98)	.000	0.89
	No	128	3.44 (3.31–3.57)	4.13 (4.00–4.25)	-0.69 (-0.84–(-0.54))	.000	0.86
Calmness	Yes	128	3.11 (3.01–3.22)	2.34 (2.21–2.47)	0.77 (0.64–0.89)	.000	0.71
	No	128	3.12 (3.00–3.24)	4.16 (4.04–4.28)	-1.04 (-1.20–(-0.88))	.000	0.93
Crying	Yes	128	3.22 (3.10–3.33)	1.89 (1.76–2.02)	1.33 (1.18–1.48)	.000	0.85
	No	128	3.25 (3.13–3.37)	3.87 (3.73–4.00)	-0.62 (-0.76–(-0.47))	.000	0.83
Physical movement	Yes	128	3.17 (3.07–3.27)	2.50 (2.39–2.62)	0.66 (0.54–0.79)	.000	0.73
	No	128	3.19 (3.07–3.31)	3.95 (3.84–4.05)	-0.76 (-0.91–(-0.60))	.000	0.89
Facial tension	Yes	128	3.25 (3.14–3.36)	2.37 (2.25–2.48)	0.88 (0.75–1.01)	.000	0.76
	No	128	3.23 (3.11–3.36)	4.16 (4.05–4.28)	-0.93 (-1.11–(-0.75))	.000	1.01
Muscle tone	Yes	128	3.26 (3.14–3.39)	2.42 (2.30–2.55)	0.84 (0.71–0.97)	.000	0.73
	No	128	3.30 (3.18–3.43)	4.05 (3.94–4.17)	-0.75 (-0.92–(-0.58))	.000	0.95
Total score	Yes	128	19.46 (18.90–20.01)	14.15 (13.60–14.70)	5.31 (4.67–5.94)	.000	3.58
	No	128	19.53 (18.96–20.10)	24.31 (23.80–24.83)	-4.78 (-5.49–(-4.07))	.000	4.05

CI=confidence interval. *Cohen's d between before and during therapy

Table 4: Subcategories alertness, calmness, crying, physical movement, facial tension and muscle tone and total COMFORT Behavior scores before and after physiotherapy sessions with and without music therapy

Instrument item	Music therapy	N	Mean before therapy (95% CI)	Mean after therapy (95% CI)	Mean difference (95% CI)	P value	Effect size*
Alertness	Yes	128	3.45 (3.30–3.60)	2.27 (2.14–2.40)	1.18 (0.99–1.4)	.000	1.02
	No	128	3.44 (3.31–3.57)	3.51 (3.37–3.65)	-0.07 (-0.24–(-0.09))	.399	0.94
Calmness	Yes	128	3.11 (3.01–3.22)	1.94 (1.82–2.07)	1.17 (1.03–1.31)	.000	0.78
	No	128	3.12 (3.00–3.24)	3.41 (3.27–3.54)	-0.29 (-0.46–(-0.12))	.001	0.97
Crying	Yes	128	3.22 (3.10–3.33)	1.39 (1.28–1.51)	1.83 (1.68–1.97)	.000	0.82
	No	128	3.25 (3.13–3.37)	2.85 (2.72–2.99)	0.40 (0.23–0.57)	.000	0.96
Physical movement	Yes	128	3.17 (3.07–3.27)	2.14 (2.03–2.26)	1.03 (0.89–1.15)	.000	0.74
	No	128	3.19 (3.07–3.31)	3.32 (3.20–3.44)	-0.13 (-0.31–0.05)	.141	1.02
Facial tension	Yes	128	3.25 (3.14–3.36)	2.06 (1.96–2.17)	1.19 (1.07–1.30)	.000	0.64
	No	128	3.23 (3.11–3.36)	3.39 (3.28–3.51)	-1.16 (-0.32–0.00)	.054	0.91
Muscle tone	Yes	128	3.26 (3.14–3.39)	1.91 (1.80–2.03)	1.35 (1.23–1.48)	.000	0.71
	No	128	3.30 (3.18–3.43)	3.31 (3.17–3.45)	-0.01 (-0.18–(-0.16))	.928	0.98
Total score	Yes	128	19.46 (18.90–20.01)	11.73 (11.22–12.24)	7.73 (7.15–8.31)	.000	3.27
	No	128	19.53 (18.96–20.10)	19.79 (19.23–20.34)	-0.26 (-1.00–0.49)	.495	4.26

CI=confidence interval. *Cohen's d between before and after therapy

All therapy interventions had nearly the same baseline values of the subcategories whether a treatment was provided with or without music therapy. This shows that every therapy started nearly under the same conditions. Our results show that the live performed music therapy is not only effective during the physiotherapy, but also afterwards (Table 4). Our investigations of the behavioral state before, during and after physiotherapy with and without live music therapy performed with the instrument sansula confirm previous results of the vital signs and show that music therapy benefits the patients during physiotherapy interventions [10]. Further studies should investigate these parameters in a larger group of patients to subdivide into different age groups, various diseases, or inpatient status. Additional studies are needed to explore whether music therapy can also be effective in other non-pharmacological therapies such as occupation-

al therapy, speech therapy and sports therapy. The results supported that the use of listening to music during physical activity increases physical performance, reduces exertion, and improves physiological performance [15], [16].

Conclusion

In summary, this study provides evidence that live performed music therapy during physical therapy benefits the patients. It adds new evidence that music therapy is effective not only on the vital signs (heart rate, respiratory rate, and oxygen saturation), blood pressure, and pain reduction but also on behavior. This research has implications for practice and policies: In addition to medical care, music therapy should be integrated into clinical routine

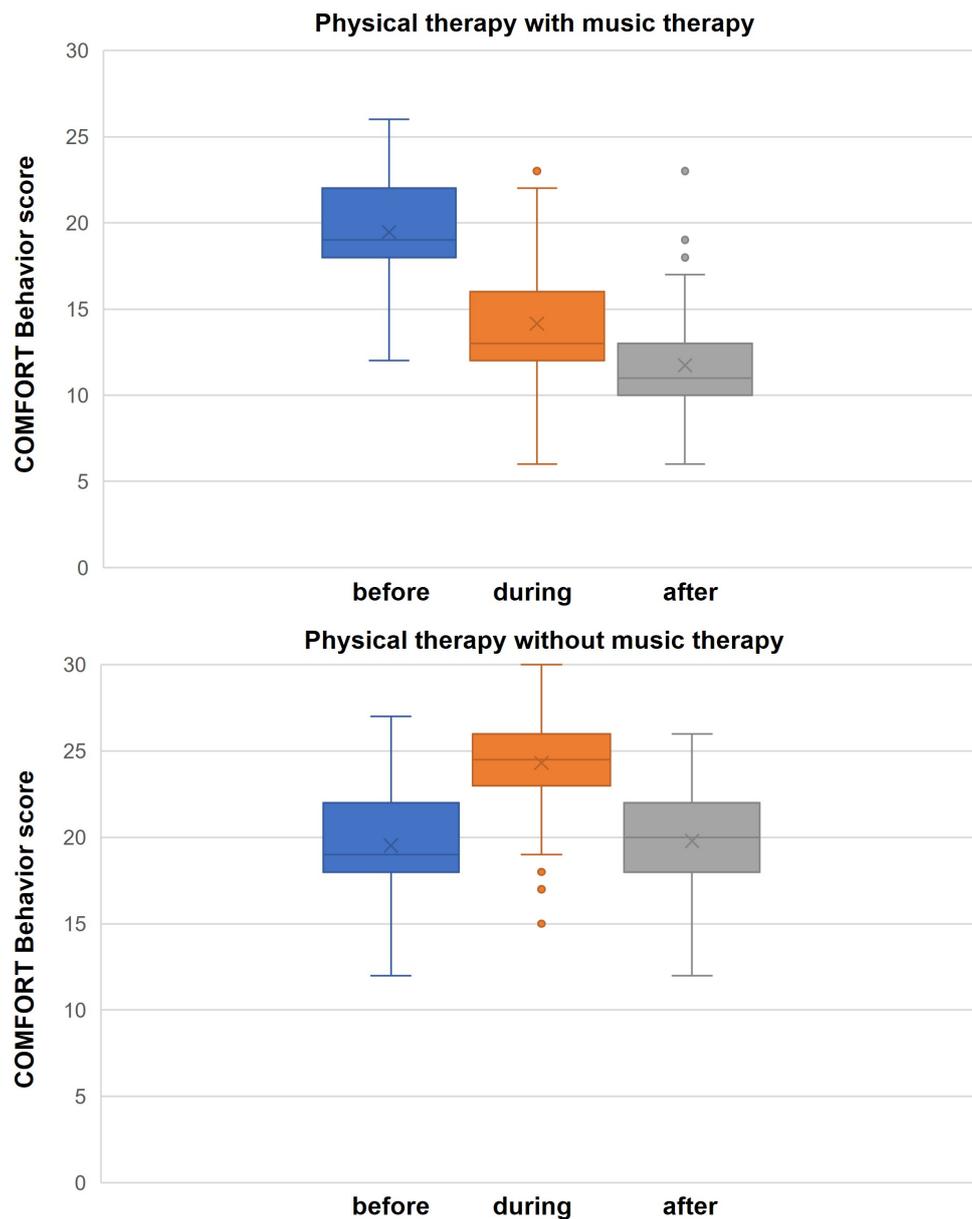


Figure 2: Total COMFORT Behavior scores before, during and after physical therapy sessions with and without music therapy

and financed by the German health insurance companies. It is greatly suited to support the patient's well-being and healing process.

Notes

Authors' contributions

Study design: S.K., F.B. and E.J.; delivery of music therapy: S.K. and F.B.; delivery of physical therapy: E.J., I.M., D.G. and R.B.; statistical analyses: S.K.; figures: S.K.; drafting of manuscript: S.K.; critical revision: E.J., F.B., O.D., M.D., I.M., D.G., R.B. All authors have read and agreed to the published version of the manuscript.

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Institutional review board statement

The study was approved by the local ethics committee of Aerztekammer Westfalen-Lippe and Westfaelische Wilhelms-University (2020-672-f-S) and registered with DRKS (DRKS00025850).

Informed consent statement

Written informed consent was obtained from the participants' parents or legal guardians before inclusion into the study.

Data availability statement

Original data will be made available to any qualified researcher upon request.

Competing interests

The authors declare that they have no competing interests.

Attachments

Available from <https://doi.org/10.3205/jat000036>

- Attachment1_jat000036.pdf (84 KB)
Table S1: Barthel Index Score of the 17 included patients at admission and at discharge

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