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Effects of a Multimodal Physiotherapy Program on Music Performance Anxiety, Pain, and Body Awareness in Young Musicians: A Randomized Controlled Trial

Genç Müzisyenlerde Müzik Performans Kaygısı, Ağrı ve Beden Farkındalığı Üzerine Multimodal Fizyoterapi Programının Etkileri: Randomize Kontrollü Bir Çalışma

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Abstract

Objective: This study aimed to investigate the effects of a two-week multimodal physiotherapy program on music performance anxiety, pain intensity, and body awareness in young musicians.

Material and Methods: Twenty-four non-professional musicians aged 18-25 years were randomly allocated to a physiotherapy group or a control group. The intervention included neural mobilization, tendon gliding, stretching, postural stabilization, and diaphragmatic breathing exercises administered three times per week for two weeks. Outcomes were assessed at baseline and post-intervention using the Kenny Music Performance Anxiety Inventory (K-MPAI), Visual Analog Scale (VAS) for pain, and Body Awareness Questionnaire (BAQ). Treatment effects were analyzed using a 2×2 mixed ANOVA.

Results: Significant group × time interaction effects were observed for all outcome measures, indicating that changes over time differed significantly between the groups. The physiotherapy group demonstrated significantly greater improvement than the control group in music performance anxiety, pain intensity, and body awareness. Significant interaction effects were found for K-MPAI ($F=64.61$, $p<0.001$, partial $\eta^2=0.746$), VAS ($F=64.00$, $p<0.001$, partial $\eta^2=0.744$), and BAQ ($F=67.90$, $p<0.001$, partial $\eta^2=0.755$).

Conclusions: A two-week multimodal physiotherapy program may provide beneficial short-term effects on music performance anxiety, pain, and body awareness in non-professional young musicians aged 18-25 years. However, the findings should be interpreted with caution due to the narrow age range and the inclusion of only non-professional participants. Further studies with larger and more diverse samples and longer follow-up are warranted.

Keywords: Musicians; music performance anxiety; pain; body awareness; physiotherapy

Öz

Amaç: Bu çalışma, iki haftalık multimodal fizyoterapi programının genç müzisyenlerde müzik performans kaygısı, ağrı şiddeti ve beden farkındalığı üzerindeki etkilerini incelemeyi amaçladı.

Materyal ve Metot: Yaşları 18-25 arasında değişen 24 profesyonel olmayan müzisyen, randomize olarak fizyoterapi grubuna veya kontrol grubuna atandı. Müdahale; sinir mobilizasyonu, tendon kaydırma egzersizleri, germe, postüral stabilizasyon ve diyafragmatik solunum egzersizlerinden oluştu ve iki hafta boyunca haftada üç kez uygulandı. Sonuç ölçümleri başlangıçta ve müdahale sonrasında Kenny Müzik Performans Kaygısı Envanteri (K-MPAI), ağrı için Görsel Analog Skala (VAS) ve Vücut Farkındalığı Anketi (BAQ) kullanılarak değerlendirildi. Tedavi etkileri 2×2 karma ANOVA ile analiz edildi.

Bulgular: Tüm sonuç ölçütleri için anlamlı grup×zaman etkileşim etkileri gözlendi; bu da zaman içindeki değişimlerin gruplar arasında anlamlı olarak farklılaştığını gösterdi. Fizyoterapi grubu, müzik performans kaygısı, ağrı şiddeti ve beden farkındalığında kontrol grubuna göre anlamlı derecede daha fazla iyileşme gösterdi. K-MPAI için ($F=64,61$, $p<0,001$, kısmi $\eta^2=0,746$), VAS için ($F=64,00$, $p<0,001$, kısmi $\eta^2=0,744$) ve BAQ için ($F=67,90$, $p<0,001$, kısmi $\eta^2=0,755$) anlamlı etkileşim etkileri bulundu.

Sonuç: İki haftalık multimodal fizyoterapi programı, 18-25 yaş arasındaki profesyonel olmayan genç müzisyenlerde müzik performans kaygısı, ağrı ve beden farkındalığı üzerinde yararlı kısa dönem etkiler sağlayabilir. Ancak, örneklemin dar yaş aralığına sahip olması ve yalnızca profesyonel olmayan katılımcıları içermesi nedeniyle bulgular dikkatle yorumlanmalıdır. Daha büyük ve daha çeşitli örneklemlerle, ayrıca daha uzun takip süreleriyle yapılacak ileri çalışmalara ihtiyaç vardır.

Anahtar Kelimeler: Müzisyenler; müzik performans kaygısı; ağrı; beden farkındalığı; fizyoterapi

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INTRODUCTION

Young instrumentalists frequently experience both physical and psychological health problems due to intensive practice schedules and performance-related pressures. Playing-related musculoskeletal disorders (PRMDs) are highly prevalent among musicians, with lifetime incidence rates reported between 46% and 90%. These conditions can adversely affect musicians' quality of life and artistic performance.[1,2] PRMDs commonly occur in the neck and shoulder regions, and each instrument presents unique postural and movement patterns that impose different biomechanical overload risks.[3] In addition to physical disorders, music performance anxiety (MPA) is another prevalent issue among young musicians, with studies indicating that severe MPA affects approximately 16-60% of musicians.[4] MPA involves intense fear and worry accompanied by autonomic symptoms such as palpitations, sweating, tremor, and muscle tension, and in severe cases, can significantly impair performance and jeopardize a musician's career.[5]

Physical problems related to instrumental performance and psychological stressors are closely interrelated in musicians. Elevated stress and MPA may increase muscle tension, alter motor control, and promote maladaptive movement strategies, thereby contributing to the development or persistence of PRMDs.[6] In parallel, insufficient body awareness and suboptimal postural habits may increase biomechanical strain during prolonged practice and performance, predisposing musicians to chronic pain and functional overload.[1]

Contemporary approaches in musician health emphasize postural education, movement efficiency, and body awareness in addition to symptom relief. The Alexander Technique may help reduce pain and muscular tension while improving self-regulation in music students.[6] Basic Body Awareness Therapy may improve muscle activation and violin technique, supporting both motor control and physical well-being in musicians.[7]

Recent evidence supports multimodal approaches that address both the physical and psychological health of musicians. Neural mobilization and tendon-gliding exercises may improve mobility and reduce upper-extremity strain, stretching and postural interventions may help reduce tension and optimize alignment, and diaphragmatic breathing may promote relaxation and self-regulation.[8-11] Yoga-based interventions have been associated with reduced pain and lower performance anxiety in adolescent musicians.[12] In addition, integrative programs combining postural retraining, therapeutic exercise, and movement re-education have demonstrated beneficial effects on playing kinematics and functional performance in college musicians.[13] Musician-specific health programs that combine education, exercise, and self-management strategies have also shown promising feasibility and clinical benefit in reducing musculoskeletal burden in student musicians.[14] Moreover, manual therapy integrated with postural exercise has been associated with greater reductions in pain and disability than exercise alone in musicians with PRMDs.[15] Collectively, these approaches suggest that musician health may benefit most from integrated interventions that combine movement re-education, postural awareness, symptom management, and self-regulation strategies rather than addressing isolated symptoms alone.

Despite growing evidence, high-quality studies evaluating physiotherapy interventions that simultaneously target multiple dimensions of performance anxiety, pain, and body awareness remain scarce in the musician population.[16] This randomized controlled trial aims to address this gap by examining the effects of a multimodal physiotherapy program on MPA, pain intensity, and body awareness in young musicians.

MATERIALS AND METHODS

Ethics Committee Approval: This study was designed as a parallel-group, assessor-blinded randomized controlled trial. Participants were allocated to the physiotherapy or control group in a 1:1 ratio using a computer-generated random sequence. Group assignment was performed by an independent researcher who was not involved in participant recruitment, assessment, or intervention procedures. Allocation concealment was maintained until the completion of baseline assessments. Due to the nature of the intervention, participant blinding was not feasible, as the physiotherapy group received active treatment, while the control group received no intervention. To minimize potential bias, participants were not informed about the study hypotheses or the expected superiority of any intervention. Outcome assessments were performed by an assessor blinded to group allocation, and statistical analyses were conducted by a researcher not involved in the intervention procedures. Ethical approval was granted by the XX University Non-Interventional Clinical Research Ethics Committee (Date: 26/07/2022, decision no: E-10840098-772.02-4244). All procedures were conducted in accordance with the Declaration of Helsinki, and written informed consent was obtained from all participants. After completion of the study, participants in the

control group were informed about the physiotherapy program and offered guidance upon request, in accordance with ethical principles.

Study Design: Eligible participants were healthy musicians aged 18-25 who played a single instrument, had at least three years of continuous experience, and engaged in regular practice. Individuals with neurological, rheumatological, or psychological disorders, a history of extremity surgery, or professional experience with more than one instrument were excluded. The primary outcome was the Kenny Music Performance Anxiety Inventory (K-MPAI). Before recruitment, an a priori power analysis was conducted using G*Power (version 3.1.9.7) based on a 2×2 repeated-measures ANOVA (within-between interaction) to reflect the group×time interaction effect of interest in a two-group pre-post randomized design. The expected effect size was informed by previous literature, including a meta-analysis on interventions targeting MPA.[17] In the absence of repeated-measures effect size estimates for physiotherapy-based interventions specifically targeting MPA, a moderate effect size (f=0.30) was assumed for the power calculation. This effect size was selected because previous intervention studies on music performance anxiety have reported variable effects, and repeated-measures estimates for short-term physiotherapy interventions in musicians are currently lacking. With α=0.05, 80% power, two groups, two measurements, a repeated-measures correlation of 0.50, and a nonsphericity correction of 1.00, the required total sample size was estimated as 24 participants. To allow for possible attrition, the planned sample size was increased by approximately 10%, resulting in a target enrollment of 26 participants. Of the 42 musicians screened, 26 met the criteria and were randomly assigned to the Physiotherapy Group (PG; n=13) or the Control Group (CG; n=13). One participant from each group later withdrew.

Interventions

Physiotherapy Group: Participants in the PG received a structured two-week program consisting of neural mobilization, tendon-gliding, stretching, postural stabilization, and diaphragmatic breathing exercises. These components were selected to address the musculoskeletal and psychophysiological demands of instrument playing. Sessions were conducted three times per week for 40-45 minutes under a physiotherapist's supervision.

Neural mobilization targeting the median, ulnar, and radial nerves (Figure 1a-c), tendon-gliding exercises for the flexor tendons (Figure 1d), and wrist–hand stretching in four directions, along with intrinsic muscle stretching (Figure 1e-f) were applied to enhance neural mobility and upper-extremity flexibility. Core and spinal mobility training included bridge and cat–camel exercises (Figure 1g-h), while thoracolumbar flexibility was supported through wall stretches and trunk-rotation tasks (Figure 1i-j). Each session concluded with diaphragmatic breathing to promote relaxation and postural control (Figure 1k). The two-week duration was selected to examine the early effects of a structured multimodal physiotherapy program in young musicians. Short-term mind-body and breathing-focused interventions have previously been used to assess early changes in stress-, anxiety-, and pain-related outcomes over brief intervention periods. However, evidence specifically examining very short-duration physiotherapy programs in musicians remains limited. Therefore, this trial was designed to focus on early therapeutic responses, and the findings should be interpreted within a short-term effects framework.

Control Group: The CG received no physiotherapeutic intervention and was asked to maintain usual daily routines and avoid starting any new physical or rehabilitation activities. This approach was intended to allow a short-term comparison of the multimodal physiotherapy program with the usual daily routine.

Demographic Information: Age, sex, height, weight, instrument-playing experience, and weekly practice duration were recorded at baseline to describe the sample and compare groups.

Outcome measures

Participants were assessed at baseline and after the two-week intervention for MPA, pain intensity, and body awareness.

Kenny Music Performance Anxiety Inventory: The K-MPAI was originally developed by Kenny in 2004 and later adapted into Turkish by Tokinan in 2013.[18,19] The K-MPAI includes 25 items across five subscales (Negative Performance Beliefs, Psychological Vulnerability, Somatic Anxiety, Personal Control, and Physiological Vulnerability). Items are rated on a 6-point Likert scale. Total scores range from 0 to 150, with values ≥105 indicating high, and ≤45 indicating low MPA.[19]

Pain: Pain intensity was evaluated using the Visual Analog Scale (VAS), where 0 indicates no pain, and 10 represents the highest pain severity. Participants marked the point that best reflected their pain level.[20]

Assessment of Body Awareness: Body awareness was measured using the Body Awareness Questionnaire (BAQ), an 18-item instrument scored on a 7-point Likert scale. The BAQ assesses sensitivity to bodily processes across

four domains, with total scores ranging from 18 to 126; higher scores indicate greater body awareness.[21] The Turkish validity and reliability study of the scale was conducted by Karaca et al.[22]

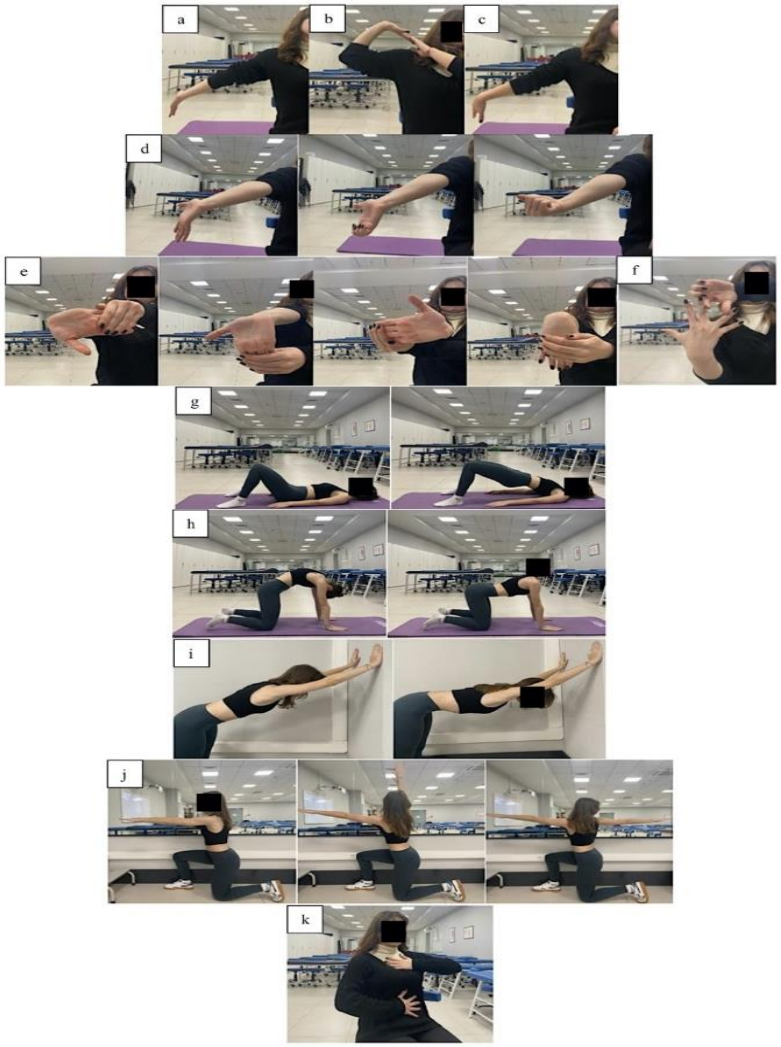


Figure 1: Physiotherapy program exercises applied in the intervention group. (a) Neural mobilization of the median nerve; (b) neural mobilization of the ulnar nerve; (c) neural mobilization of the radial nerve; (d) tendon gliding exercise; (e) four-directional wrist and hand muscle stretching; (f) intrinsic hand muscle stretching; (g) bridge exercise; (h) cat–camel exercise; (i) back muscle stretching; (j) wall–torso rotation; (k) diaphragmatic breathing exercise.

Statistical Analysis: All statistical analyses were performed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented according to data distribution. Continuous variables with normal distribution were expressed as mean±standard deviation, whereas non-normally distributed continuous variables were presented as median (Q1-Q3). Categorical variables were expressed as numbers and percentages. Normality was assessed using the Shapiro-Wilk test and visual inspection of distribution plots. Baseline comparisons were performed using the Chi-square test, independent samples t-test, or Mann-Whitney U test, as appropriate. Treatment effects were primarily analyzed using a 2×2 mixed ANOVA, with group as the between-subject factor and time as the within-subject factor. Main effects of group and time, as well as the group × time interaction, were examined. Bonferroni-adjusted post hoc comparisons were applied where appropriate to control for inflation of Type I error due to multiple testing, and effect sizes were reported as partial eta square (η^2p). Supportive pairwise comparisons were also conducted using appropriate parametric or non-parametric tests. A two-sided p-value of < 0.05 was considered statistically significant.

RESULTS

Twenty-four participants completed the study, with 12 participants in the physiotherapy group and 12 in the control group. As shown in Table 1, the groups did not differ significantly at baseline with respect to age, sex distribution, height, weight, instrument-playing experience, or weekly practice duration (all p>0.05), indicating baseline comparability.

Table 1. Characteristics of the participants.

Variables	Physiotherapy Group	Control Group	p
Age, years, Median (Q1-Q3)	20.5 (18.75-22.00)	20.5 (19.00-22.25)	0.792[a]
Height, cm, Mean±SD	173.33±9.39	170.00±8.51	0.372[b]
Weight, kg, Mean±SD	71.17±18.62	68.58±16.36	0.721[b]
Gender, M/F (M%)	8/4 (66.6%)	7/5 (58.33%)	1.000[c]
Instrument playing experience, months, Median (Q1-Q3)	66.0 (57.0-79.5)	57.0 (48.0-72.0)	0.222[a]
Weekly instrument practice duration, hours, Mean±SD	11.75±2.70	10.08±2.50	0.131[b]

SD: Standard deviation; Q1-Q3: 25th-75th percentile.; F: Female; M: Male; [a]: Mann-Whitney U test, [b]: Independent samples t-test, [c]: Chi-square test; p<0.05.

As presented in Table 2, baseline K-MPAI, VAS, and BAQ scores were also comparable between the groups (all p>0.05). Post-intervention between-group comparisons demonstrated significant differences in all outcome measures in favor of the physiotherapy group (K-MPAI, p=0.010; VAS, p<0.001; BAQ, p=0.002). Complementary within-group analyses showed significant pre- to post-intervention improvements across all outcomes in the physiotherapy group. In contrast, the control group showed no significant change in VAS or BAQ scores, while K-MPAI increased significantly, although the magnitude of this change was small. These pairwise results should be interpreted together with the primary 2×2 mixed ANOVA findings presented in Table 3.

Table 2. Descriptive pre- and post-intervention outcome measures with supportive within-group and between-group comparisons.

Variables	Physiotherapy Group				Control Group					
	Baseline (Mean ± SD) 95% CI (Lower / Upper)	Post (Mean ± SD) 95% CI (Lower / Upper)	Within-group $p^{a,b}$	ES	Baseline (Mean ± SD) 95% CI (Lower / Upper)	Post (Mean ± SD) 95% CI (Lower / Upper)	Within-group $p^{a,b}$	ES	Baseline between-group $p^{c,d}$	Post-intervention between-group $p^{c,d}$
K-MPAI	80.08 ± 9.17 (74.26 / 85.91)	68.67 ± 7.63 (63.82 / 73.52)	**<0.001**[b]	2.21	76.58 ± 7.96 (71.53 / 81.64)	77.50 ± 7.51 (72.73 / 82.27)	**0.020**[b]	0.13	0.329[d]	**0.010**[d]
VAS	2.92 ± 1.16 (2.18 / 3.66)	0.42 ± 0.51 (0.09 / 0.74)	**<0.001**[a]	0.94	2.25 ± 1.14 (1.53 / 2.97)	2.42 ± 1.16 (1.68 / 3.16)	0.317[a]	0.26	0.170[c]	**<0.001**[c]
BAQ	83.42 ± 5.84 (79.71 / 87.13)	93.08 ± 4.70 (90.10 / 96.07)	**<0.001**[a]	0.88	82.17 ± 6.98 (77.73 / 86.60)	82.58 ± 6.95 (78.17 / 87.00)	0.340[a]	0.25	0.664[c]	**0.002**[c]

VAS: Visual Analog Scale; BAQ: Body Awareness Questionnaire; K-MPAI: Kenny Music Performance Anxiety Inventory; SD: standard deviation; ES: Effect sizes were calculated using rank-biserial correlation (r) for non-parametric tests and Cohen's d for parametric tests; [a]: Wilcoxon signed-rank test was used for non-normally distributed variables; [b]: Paired sample t-test was used for normally distributed variables; [c]: Mann–Whitney U test was used for between-group comparisons of non-normally distributed variables; [d]: Independent samples t-test was used for between-group comparisons of normally distributed variables; p<0.05.

As shown in Table 3, the 2×2 mixed ANOVA revealed significant group × time interaction effects for all outcome measures, indicating that the pattern of change over time differed significantly between the physiotherapy and control groups. Significant interaction effects were observed for K-MPAI (F=64.61, p<0.001, partial η^2=0.746), VAS (F=64.00, p<0.001, partial η^2=0.744), and BAQ (F=67.90, p<0.001, partial η^2=0.755). Significant main effects of time were also identified for all outcome measures. Among the main effects of group, only BAQ reached statistical significance (F=5.76, p=0.025, partial η^2=0.208). In line with these findings, Bonferroni-adjusted pairwise comparisons confirmed significantly better post-intervention scores in the physiotherapy group.

Table 3. Main effects of group and time, and group × time interaction effects for K-MPAI, VAS, and BAQ in the 2×2 mixed ANOVA.

Variables	Effect	F	p	Partial η^2
K-MPAI	Group	0.66	0.423	0.029
	Time	48.22	**<0.001**	0.687
	Group×Time	64.61	**<0.001**	0.746
VAS	Group	2.95	0.099	0.119
	Time	49.00	**<0.001**	0.690
	Group×Time	64.00	**<0.001**	0.744
BAQ	Group	5.76	**0.025**	0.208
	Time	77.95	**<0.001**	0.780
	Group×Time	67.90	**<0.001**	0.755

VAS: Visual Analog Scale; BAQ: Body Awareness Questionnaire; K-MPAI: Kenny Music Performance Anxiety Inventory. **Note:** A 2×2 mixed ANOVA was performed with group (physiotherapy vs control) as the between-subject factor and time (pre-intervention vs post-intervention) as the within-subject factor. Main effects of group and time, as well as the group×time interaction, are presented. Bonferroni-adjusted post hoc comparisons were applied where appropriate to control for multiple testing. Statistical significance was set at $p<0.05$.

DISCUSSION AND CONCLUSION

In this study, the 2×2 mixed ANOVA demonstrated significant group×time interaction effects for MPA, pain intensity, and body awareness, indicating that the physiotherapy group improved significantly more over time than the control group. These findings suggest that the multimodal physiotherapy program exerted a meaningful short-term effect on both psychological and physical domains in young musicians. Importantly, the magnitude of improvement exceeded widely accepted thresholds for clinical relevance. A reduction of ≥2 points on the VAS is considered clinically meaningful in musculoskeletal pain populations,[23] and the observed decrease of 2.50 points clearly surpasses this benchmark. Similarly, minimally important differences for self-report scales are typically defined as changes ≥0.5 standard deviation (SD),[24,25] in the present study, BAQ scores increased by nearly 1.5 SD and K-MPAI scores decreased by approximately 1.2 SD. These values correspond to moderate-to-large effect sizes, indicating that the observed improvements were not only statistically significant but also robust and clinically meaningful. Taken together, these findings support the therapeutic potential of a short-term multimodal intervention for pain, anxiety, and body awareness in musicians, although they should be interpreted as early responses rather than sustained effects. Nevertheless, these findings should be considered preliminary, as the intervention period was brief and the observed effects reflect short-term responsiveness rather than established long-term efficacy. This interpretation is consistent with previous musician-focused studies showing that clinically relevant improvements may emerge even after brief intervention periods.[26] In addition, Roos et al. demonstrated that a musician-specific workplace injury prevention and wellness program reduced playing-related musculoskeletal pain, while Wolff et al. reported that a musculoskeletal health program for student musicians showed promising feasibility and beneficial effects on pain-related outcomes. Although these interventions differed in content and duration from the present protocol, together they support the view that structured, musician-oriented interventions can yield meaningful early benefits, particularly for pain-related and functional outcomes.[27,28] Our findings are broadly consistent with previous intervention studies aimed at reducing performance anxiety and musculoskeletal symptoms in musicians. Khalsa and colleagues reported significant reductions in performance anxiety following a yoga-based intervention in adolescent musicians, supporting the idea that non-pharmacological and body-oriented approaches may positively affect anxiety-related outcomes in this population.[12] Likewise, Assel et al. showed that a short course of manual therapy tailored to the musician's specific complaints reduced pain levels in music students with playing-related musculoskeletal disorders.[15] Although the intervention content and treatment duration were not identical to those of the present study, these reports are important because they indicate that clinically relevant changes in musician health outcomes can occur without prolonged treatment periods.[12,15] In this respect, the present findings extend the literature by suggesting that a two-week multimodal physiotherapy program may simultaneously influence pain, performance anxiety, and body awareness, rather than targeting only a single domain.

Previous studies have shown that targeted exercise and physiotherapy can reduce pain in musicians; however, evidence simultaneously addressing pain, anxiety, and body awareness remains limited. In this respect, our findings extend the literature and are consistent with evidence that body-oriented approaches may improve posture

and reduce unnecessary muscular tension in performers.[29] Moreover, a recent study in young adults found body awareness levels to be directly related to musculoskeletal pain and emotional state[30], suggesting that improving awareness may contribute to pain reduction and better mental health. Overall, our findings suggest that a short-term multimodal program may beneficially influence both MPA and musculoskeletal pain in musicians. A plausible mechanism is that neural mobilization and tendon-gliding exercises may have improved peripheral nerve mobility, reduced upper-extremity irritation related to repetitive playing, and supported more efficient sensorimotor control during performance.[31]

Second, stretching and postural stabilization may have contributed to pain relief and improved body awareness by reducing muscle tension and musculoskeletal strain.[32] Improved postural alignment and core stabilization may reduce biomechanical load during instrument playing and help interrupt the bidirectional relationship between pain and anxiety.[17,33] By improving posture and reducing pain, the intervention may have lessened the bodily stress signals that fuel performance anxiety. The significant increase in BAQ scores suggests participants became more attuned to their body signals and posture. MPA is characterized not only by cognitive symptoms but also by prominent physiological and somatic manifestations, including increased heart rate, tremor, sweating, and muscle tension. In this context, the improvement in body awareness observed in our study may be clinically relevant, as greater awareness of bodily signals may facilitate earlier recognition and regulation of somatic tension during performance. This interpretation is in line with evidence suggesting that interventions targeting interoceptive or body-related awareness may reduce somatic symptoms and anxiety-related distress.[34-36] Such heightened body awareness can enable early recognition and correction of unhealthy tension while playing, preventing pain escalation.[30] It may also foster a sense of physical control that translates into psychological confidence on stage.

Third, diaphragmatic breathing may have contributed to reduced MPA by enhancing relaxation and autonomic regulation. Consistent with previous evidence, slow and controlled breathing may increase parasympathetic activity and reduce stress- and anxiety-related symptoms.[33] In musicians, diaphragmatic breathing may help attenuate acute autonomic arousal under performance pressure, while also supporting core stability and postural control. Together, neural mobilization, stretching/postural training, and breathing exercises may address both the physical tension and psychophysiological arousal underlying MPA and pain, consistent with findings from holistic approaches such as yoga in musician populations.[8-11,33,37]

In conclusion, this study suggests that a two-week multimodal physiotherapy program may have beneficial short-term effects on MPA, pain, and body awareness in non-professional young musicians aged 18-25 years. The combination of neural mobilization, tendon-gliding exercises, stretching, postural training, and diaphragmatic breathing appears to target both physical and psychological processes simultaneously, which may contribute to a more integrated therapeutic response. Short, non-pharmacological interventions of this kind could represent a promising option within musicians' health and may offer a feasible model for implementation in music schools and clinical settings. However, these findings should be interpreted with caution, as their generalizability is limited by the narrow age range of the sample and the inclusion of only non-professional participants. The observation that the improvements exceeded minimal clinically important thresholds indicates that participants may have perceived these changes as meaningful in their day-to-day functioning. This study has several strengths, including its randomized controlled design, assessor-blinded outcome evaluation, and multimodal physiotherapy approach targeting both physical and psychological domains. In addition, the simultaneous assessment of MPA, pain, and body awareness provided a broader perspective on the short-term effects of the intervention. However, the findings should be interpreted in light of several limitations, including a small sample size, reliance on self-report measures, limited long-term follow-up, and inclusion of only non-professional young musicians aged 18-25 years. The absence of an active or sham control group also limits the ability to fully exclude expectancy and other nonspecific treatment effects. Furthermore, participants were not classified according to instrument groups, despite the distinct postural and musculoskeletal demands associated with different instruments. Finally, the two-week intervention period precludes conclusions regarding the durability of treatment effects. Future studies should use larger, more diverse samples, longer interventions, and follow-up assessments to confirm the durability of the effects. Objective performance and physiological measures, as well as designs that isolate specific treatment components or use active controls, may help clarify mechanisms and strengthen causal inference. Integrating multimodal approaches into music education may also have preventive and clinical value. Overall, interventions addressing both physical and psychological domains merit further investigation in musicians' health.

Ethics Committee Approval: This study was conducted as a parallel-group, assessor-blinded randomized controlled trial with a 1:1 allocation ratio. Ethical approval was granted by the XX University Non-Interventional Clinical Research Ethics Committee (Date: 26/07/2022, decision no: E-10840098-772.02-4244). All procedures were conducted in accordance with the Declaration of Helsinki, and written informed consent was obtained from all participants.

Conflict of Interest: The author(s) declare no conflict of interest.

Authors' Contributions: Concept – ED; Supervision – ED, BM; Materials – ED, BM; Data Collection and/or Processing – ED; Analysis and/or Interpretation – ED; Writing –ED, BM.

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