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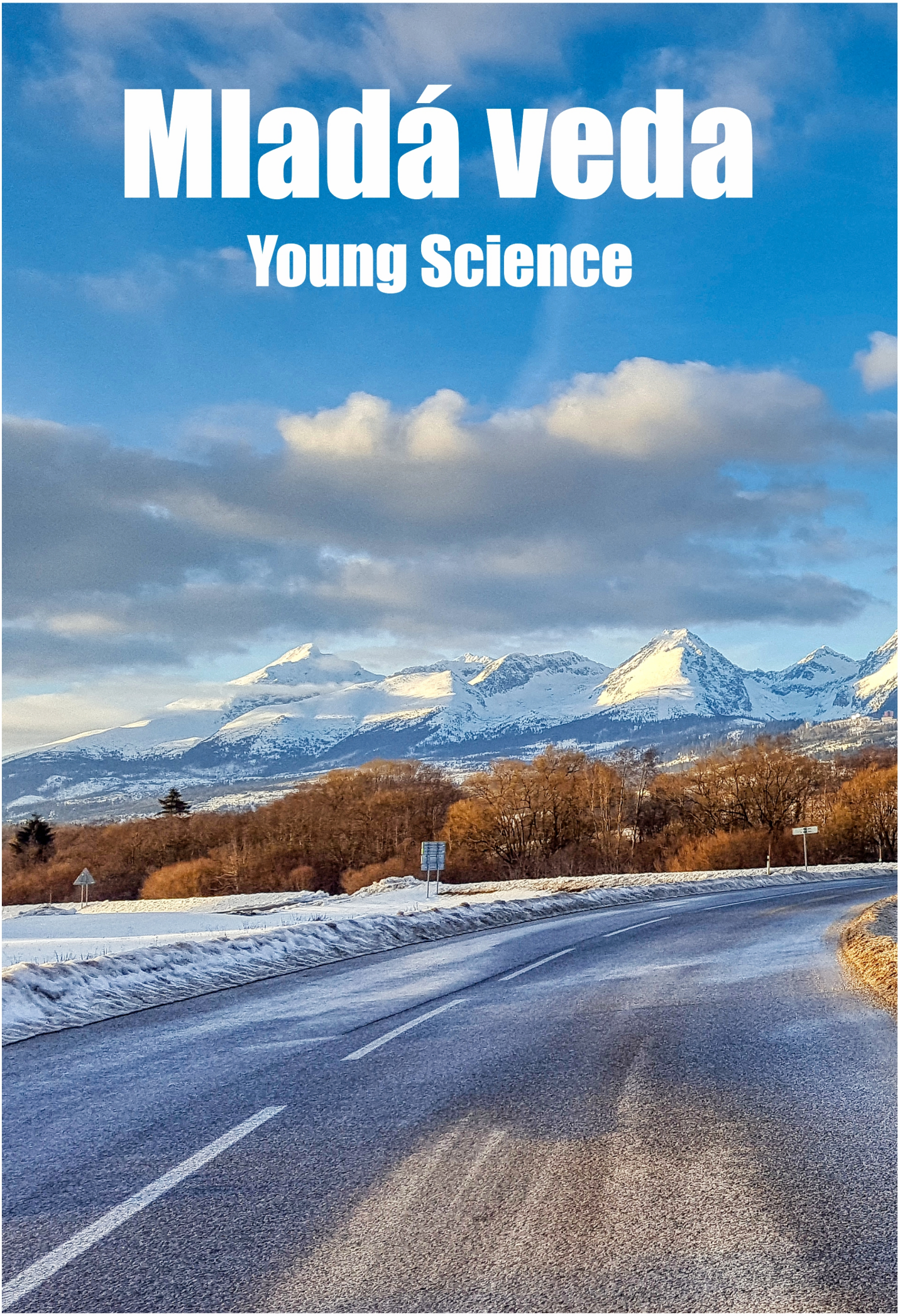

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ANALÝZA VÝSKYTU OSLABENÝCH SVALOV TRUPU U ŠTUDENTIEK FAKULTY MÚZICKÝCH UMENÍ AKADÉMIE UMENÍ V BANSKEJ BYSTRICI

ANALYSIS OF THE OCCURRENCE OF TRUNK MUSCLE WEAKNESS IN FEMALE STUDENTS OF THE FACULTY OF PERFORMING ARTS AT THE ACADEMY OF ARTS IN BANSKÁ BYSTRICA

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Abstract
Music students are frequently exposed to prolonged unilateral and static postural demands during instrumental performance or singing. Such loading patterns contribute to muscular imbalance, typically manifesting as weakness of key stabilizing muscle groups and impaired postural control. This study aimed to examine the prevalence of trunk muscle weakness among female students of the Faculty of Performing Arts at the Academy of Arts in Banská Bystrica, with emphasis on the abdominal muscles, deep cervical flexors, and lower scapular stabilizers. Fifty-six female students (mean age 22.74 years) enrolled in full-time performance-based study programs participated in the study. Functional capacity of selected muscle groups was evaluated using standardized manual muscle tests according to Thurzová (1992). Weakness was identified across all muscle groups assessed. Abdominal muscle weakness was observed in 42.86% of participants, deep cervical flexor weakness in 50.00%, and lower scapular stabilizer weakness in 57.14%. The high prevalence of these deficits indicates substantial impairment of trunk stabilization mechanisms and suggests an elevated risk for the development of upper and lower crossed syndromes. The findings highlight a considerable occurrence of weakness within the deep stabilization system in female music students. Such deficits represent critical risk factors for postural dysfunction and musculoskeletal disorders, underscoring the necessity of early preventive strategies. Routine musculoskeletal assessment, targeted strengthening of weakened muscles, and the integration of physiotherapeutic interventions into the educational process are strongly recommended to promote health and ensure the long-term sustainability of students' artistic performance.
Key words: muscular imbalance, students of performing arts, trunk muscle weakness

Abstrakt
Študenti hudobných odborov sú vystavení dlhodobému jednostrannému a statickému zaťaženiu pri hre na nástroj alebo speve. Tento typ záťaže prispieva k vzniku svalovej dysbalancie, ktorá sa prejavuje oslabením stabilizačných svalových skupín a poruchami posturálnej kontroly. Cieľom štúdie bolo analyzovať výskyt oslabených svalov trupu u študentiek Fakulty múzických umení Akadémie umení v Banskej Bystrici, so zameraním na brušné svalstvo, hlboké ohýbače krku a hlavy a dolné fixátory lopatiek. Výskumu sa zúčastnilo 56 študentiek (priemerný vek 22,74 roka) zapísaných v denných študijných programoch interpretačného umenia. Funkčný stav vybraných svalových skupín bol hodnotený pomocou štandardizovaných testov podľa Thurzovej (1992). Analýza poukázala na oslabenie vo všetkých sledovaných svalových skupinách. V brušnom svalstve bolo oslabenie prítomné u 42,86 %, v hlbokých flexoroch krku u 50,00 % a v dolných fixátoroch lopatiek až u 57,14 % študentiek. Tento podiel oslabených svalov signalizuje významné narušenie stabilizačných mechanizmov trupu a riziko rozvoja horného a dolného skríženého syndrómu. Zistenia potvrdzujú vysoký výskyt oslabených stabilizačných svalov, čo poukazuje na komplexné narušenie hlbokého stabilizačného systému u študentiek hudobných odborov. Identifikované deficity predstavujú rizikový faktor pre vznik posturálnych porúch a muskuloskeletálnych ťažkostí. Do edukačného procesu je potrebné integrovať pravidelné hodnotenie funkčného stavu pohybového aparátu, cielené posilňovanie oslabených svalov a

fyzioterapeutické intervencie. Tieto opatrenia môžu významne prispieť k podpore zdravia študentiek a dlhodobej udržateľnosti ich umeleckej činnosti.
Kľúčové slová: svalová nerovnováha, študenti múzických umení, oslabenie svalov trupu

Theoretical Background

Muscular imbalance is among the most common functional disorders of the musculoskeletal system. In clinical practice, three primary syndromes are most frequently described—Upper Crossed Syndrome (UCS), Lower Crossed Syndrome (LCS), and Layer Syndrome (Janda's Layer Syndrome). These entities were originally delineated by Janda (1988) and subsequently elaborated by other authors (Sahrmann, 2002; Puagprakong et al., 2022; Chang et al., 2023).

U pper Crossed Syndrome (Kolář, 2010) is characterized by an imbalance between shortened and weakened musculature in the cervical spine and shoulder girdle. Clinically salient weakened groups include the deep cervical flexors (m. longus colli, m. longus capitis, and the scalene muscles—mm. scaleni) and the lower scapular stabilizers (mm. rhomboidei, lower fibers of m. trapezius, and m. serratus anterior). Weakness in these groups manifests as impaired scapular stabilization and forward head posture.

Lower Crossed Syndrome denotes imbalance in the trunk–pelvic region, with predominant weakness of the abdominal wall, m. rectus abdominis, m. obliquus externus, m. obliquus internus, and m. transversus abdominis, associated with reduced trunk stability, increased lumbar lordosis, and anterior pelvic tilt.

Layer Syndrome presents alternating patterns of hypotonic and hypertonic muscle groups. From the standpoint of weakness, key regions include the gluteal muscles, lumbosacral paravertebral muscles, periscapular (interscapular) musculature, and the abdominal wall, which collectively contribute critically to trunk stabilization (Kolář, 2010).

Music students constitute a high-risk population for muscular imbalance due to prolonged static or asymmetrical postures during instrumental performance or singing, predisposing them to functional impairments and pain, particularly in the neck, shoulder, and trunk.

Steinmetz et al. (2012) reported that up to 93% of musicians with playing-related musculoskeletal disorders (PRMD) exhibited impaired postural stabilization systems, most commonly involving scapular and lumbopelvic stabilizers and a high incidence of UCS; prevalence was higher among string players and women. In the European RISMUS study, Cruder et al. (2020) found that nearly half of music students (48%) reported PRMD, with risk factors including study in Western Europe, higher academic level (1st–2nd year of master's), longer practice duration, and greater perceived exertion after 45 minutes of uninterrupted playing. Carroll (2020) emphasized substantial unilateral loading in young violinists and violists, predisposing to postural imbalance and long-term alignment changes. Johansson et al. (2015) reported that 91% of Swedish professional orchestral musicians experienced musculoskeletal pain in the previous year, most commonly cervical; regression analyses identified sex as a predictor of hip pain and playing posture as a predictor of knee pain, while overall physical activity did not show a significant protective effect.

Early identification of weakened or overactivated muscle groups is essential for prevention and treatment of movement disorders. As outlined by Sahrmann et al. (2002),

clinical assessments of muscle activation enable targeted identification of vulnerable regions and prescription of exercise strategies to restore postural balance and function.

Blanco-Piñeiro et al. (2017) demonstrated growing interest in links between musicians' postural quality and musculoskeletal health but highlighted methodological heterogeneity that limits firm conclusions and comparability with the general population, underscoring the need for standardized tools and definitions. Rousseau et al. (2023) likewise confirmed the value of routine postural assessment and called for consistent methodologies to facilitate early detection of maladaptive movement patterns and reduce PRMD risk.

Conversely, some research cautioned against an exclusively postural explanation of PRMD. Bruyneel et al. (2024) argued that music students face combined physical and psychological stressors, including performance anxiety, perfectionistic tendencies, and heightened stress reactivity, advocating a comprehensive biopsychosocial approach to prevention and care. Kenny & Ackermann (2013) further showed associations between PRMD, performance anxiety, and depressive symptoms in professional musicians, reinforcing the need for integrated strategies.

Within the specific context of the Faculty of Performing Arts, where high demands on bodily control, precision, and endurance are routine, analyzing weakened muscle groups and postural disorders is particularly pertinent. Such analysis provides a basis for preventive and educational programs that support students' health and the long-term sustainability of artistic performance. Collectively, the literature supports focused evaluation of muscle groups essential for optimal performance posture, as dysfunction may drive maladaptive movement patterns, increased loading, and, ultimately, PRMD.

Methods

The study sample comprised 56 female students of the Faculty of Performing Arts at the Academy of Arts in Banská Bystrica, all enrolled in full-time, performance-oriented study programs. Participants represented a range of artistic specializations and departments, including wind and string instruments, keyboard instruments, piano collaboration, composition, vocal performance, and choral conducting. The mean age of the cohort was 22.74 years.

Prior to enrolment, all participants were thoroughly informed about the aims, procedures, and ethical aspects of the study. Voluntary participation was confirmed through written informed consent, thereby ensuring full compliance with ethical research standards.

Data collection and functional testing were carried out under controlled conditions on the faculty premises at the beginning of the summer semester of the 2023/2024 academic year. Muscle weakness was assessed using standardized functional tests described by Labudová &Thurzová (1992):

- Abdominal muscles

Procedure: Performed in the supine position with knees flexed, feet flat on the floor, and arms extended forward. The subject attempted a curl-up by sequentially lifting the head, shoulders, thorax, and lumbar spine (rounded-back movement).

Norm: A smooth, controlled transition to the seated position, with the trunk segmentally rolling off the floor up to the pelvic margin.

Weakness: Only the head, shoulders, or scapulae are lifted, or the subject rises abruptly with a straight back, indicating a faulty movement pattern.

- Deep cervical flexors

Procedure: Supine position with arms alongside the body. The subject lifted the head so that the chin touched the suprasternal notch and maintained the position for 20 seconds.

Norm: Ability to hold the position steadily for the full 20 seconds.

Weakness: The head dropped before the required time, or the effort was accompanied by shaking, indicating poor endurance of the deep cervical flexors.

- Lower scapular stabilizers

Procedure: Quadruped position with hands shoulder-width apart and fingers pointing forward. From this position, the subject slowly lowered the body by flexing the elbows into a prone posture, while scapular alignment and shoulder girdle control were observed.

Norm: Scapulae remained closely aligned with the thoracic wall without winging.

Weakness: The medial borders of the scapulae protruded or shifted upward.

Results

The functional assessment of selected muscle groups demonstrated weakness in all examined regions, with prevalence varying across specific groups. These findings indicate a high occurrence of functional deficits within stabilizing muscle systems, which are essential for maintaining physiological postural alignment. Abdominal muscle weakness was identified in 42.86% of students, whereas 57.14% exhibited normal function. This suggests that nearly half of the cohort presented reduced activation of the central stabilization system. Functionally, the deficit was manifested by an inability to perform a smooth, segmental curl-up with a rounded back. Weakness of the deep cervical flexors was observed in 50.00% of participants, with the remaining half demonstrating preserved function. These muscles serve as a fundamental stabilizing mechanism for proper head and cervical spine positioning. Identified weakness was evident in the inability to achieve full cervical flexion to the chest or through compensatory activation of superficial cervical muscles. This result is clinically relevant, as it reflects disruption of the deep stabilizing system of the cervical region, closely associated with Upper Crossed Syndrome. The highest prevalence of weakness was recorded in the lower scapular stabilizers, where 57.14% of students exhibited functional impairment, while 42.86% retained adequate scapular control.

Discussion

Musicians constitute a distinct population that, due to unilateral and repetitive loading, is particularly vulnerable to muscular imbalance. The present findings confirmed that weakness of selected muscle groups is evident in this population and has a significant impact on overall functional stability. Importantly, such deficits are not unique to musicians; comparable manifestations have been observed in the general child and adolescent population, where they often reflect broader systemic issues of muscular balance and postural control, as reported in several studies. In our sample, weakness of the lower scapular stabilizers was identified in 57.14% of participants, representing more than half of the cohort. From a functional anatomical perspective, this is highly relevant, as weakness of these muscles is considered a

hallmark of Upper Crossed Syndrome. Lenková & Boržíková (2018) described this syndrome as being characterized by weakness of shoulder girdle muscles, particularly the lower scapular stabilizers and deep cervical flexors, which externally manifests as rounded shoulders, forward head posture, and increased thoracic kyphosis. Our findings also align with Bendíková et al. (2015), who reported weakness of the lower scapular stabilizers in 60.9% of 336 female secondary school students (mean age 17.5 years). She emphasized that this weakness is one of the most common deficits in the adolescent population and is closely linked to dysfunctional movement patterns, such as impaired shoulder abduction, which she identified in 53.5% of her cohort. Moreover, Bendíková et al. (2015) observed weakness of the abdominal muscles in 79.2% of participants, underscoring their essential role in trunk and spinal stabilization. Such deficits contribute to disruption of the deep stabilization system and create a predisposition for the development of Lower Crossed Syndrome, typically manifested by increased lumbar lordosis and anterior displacement of the abdominal segment.

The importance of lower scapular stabilizers as an indicator of poor posture was further highlighted by Kanásová et al. (2016), who demonstrated that scapular winging was one of the most prominent postural deviations in boys aged 11–15 years. This deficit was observed in 82.3–94% of cases across all measurements. By the sixth grade of primary school, scapular winging had already become the most frequent postural marker (88.2%), followed by abnormalities in the shoulders and pelvis (88.2%) and the spine (76.5%). Similarly, Vasiľovský and Kanásová (2015) reported a high prevalence of abdominal muscle weakness in fifth-grade students, with 50% of children demonstrating deficits. This finding is alarming, given the abdominal wall's fundamental role within the deep stabilization system in maintaining posture, dynamic trunk stability, and injury prevention. The authors emphasized that such weakness is frequently associated with insufficient physical activity, imbalanced loading, and maladaptive postural habits, which, if unaddressed, may lead to long-term functional impairments.

The critical role of trunk musculature in posture and motor control was further confirmed by Dop et al. (2024), who reported that adequately strong trunk muscles are essential for postural stabilization, movement coordination, and overall motor performance. Weakness in this region may not only compromise posture but also limit the execution of daily motor tasks. Their study indicated that children with developmental coordination disorder (DCD) exhibited pronounced weakness of the trunk, particularly the abdominal and lumbosacral paravertebral muscles, which represented a key limiting factor in balance maintenance and effective motor skills.

The vulnerability of music students to muscular imbalance was also documented by Araújo et al. (2020), who identified multiple areas of weakness and imbalance negatively affecting both performance and musculoskeletal health. Their plank test results placed trunk endurance and core stability below the 30th percentile for both sexes, indicating insufficient activation of the core musculature and reduced capacity to sustain prolonged load. In addition, sit-and-reach scores fell below population averages, suggesting limited hamstring and lumbar flexibility, which may increase the risk of low back pain and postural dysfunction. Imbalances were also pronounced in the shoulder region: 17% of participants reported pain during internal rotation of the right shoulder, and asymmetries in range of motion were noted

between sides. These results likely reflect the unilateral and repetitive demands of instrumental performance.

The musculoskeletal challenges faced by musicians extend beyond the trunk and scapular stabilizers to peripheral regions, particularly the forearm and hand. Uneven loading often results in overactivation of the long finger flexors while the small intrinsic hand muscles remain underutilized, further exacerbating imbalance and predisposing to pain or fine-motor dysfunction. Basseri et al. (2025) reported that musicians frequently demonstrate this pattern, which may lead to fatigue and discomfort if not addressed with appropriate compensatory exercises.

The issue of muscular overload during instrumental performance has also been investigated by Ziane et al. (2024), who examined the use of dynamic assistive support (DAS) in violinists. Their findings showed that DAS significantly reduced fatigue of the cervical and shoulder girdle muscles-specifically the supraspinatus, trapezius, and deltoid—during prolonged performance. These results highlight the importance of compensating for unilateral and repetitive strain, which, if unmitigated, may lead to overuse injuries and dysfunction across multiple segments of the musculoskeletal system.

Conclusion and Practical Recommendations

The findings of this study demonstrate that weakness of stabilizing muscle groups is a frequent and substantial problem among music students, with the highest prevalence identified in the lower scapular stabilizers. These muscles are essential for maintaining functional posture, and their weakness is closely associated with Upper Crossed Syndrome. Marked deficits were also observed in the deep cervical flexors and abdominal musculature, reflecting a complex disturbance of the deep stabilization system. These outcomes are consistent with both national and international research reporting a high prevalence of muscular imbalances among children, adolescents, and musicians.

From a practical standpoint, it is crucial to integrate systematically targeted exercises into the daily training routines of musicians, particularly stabilization, postural, and compensatory exercises aimed at activating and strengthening weakened muscle groups. Regular assessment of musculoskeletal function, the application of individually tailored exercise programs, and the inclusion of physiotherapeutic interventions into professional music education are strongly recommended. Such measures will help ensure that music students are able to develop and perform their art in a healthy, effective, and sustainable manner.

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