Intervention Program in College Instrumental Musicians, with Kinematics Analysis of Cello and Flute Playing

A Combined Program of Yogic Breathing and Muscle Strengthening-Flexibility Exercises

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College musicians encounter health risks not dissimilar to those of professional musicians. Fifteen collegiate instrumental musicians participated in the intervention program of yogic-breathing and muscle-strengthening and flexibility exercises for 8 weeks. Pre- and post-intervention data from the Health-Pain-Injury Inventory (HPI) and the Physical & Musical-Performance Efficacy Assessment Survey (PME) were analyzed for the effects of the program on the musicians' physical and musical-performance efficacy. HPI results showed that the majority of our sample had healthy lifestyles and minimal pain and injuries but irregular eating and exercise habits. The pre-intervention PME data showed a high level of musical efficacy (i.e., awareness of music technique, tone, and flow) but a low-level of physical efficacy (i.e., awareness of posture, tension, and movement flexibility). Post-intervention data showed that the program improved physical efficacy by increased awareness of posture and tension. In 2 volunteer musicians, kinematics motion analysis was conducted for exploratory purposes. Our cellist played the scale using a larger range of motion (ROM) in right shoulder flexion and abduction and slightly increased rotation while keeping decreased right elbow ROM after the intervention program. The flutist shifted the body weight from one foot to the other more in the second playing post-intervention. These changes can be attributed to the increased physical efficacy that allowed freedom to express musicality. Findings from these case scenarios provide empirically based hypotheses for further study. We share our experience so that others may use our model and instruments to develop studies with larger samples. *Med Probl Perform Art* 2012; 27(2):85–94.

College musicians' performance-related health issues have become amplified parallel to the increased rigor in music training and the intense lifestyle of our ambitious youth.[1-8] The general consensus is that college musicians do not have the means to prevent injuries, nor do they seek treatment once injuries have occurred.

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Overuse injuries involving muscle-tendons are the most common problems, with symptoms ranging from mild to severe pain[9] in the neck, shoulder, and back.[1] Moreover, the bodily origins of the physical problems, whether of musculoskeletal or non musculoskeletal nature, are of little variation across the musicians.[10]

As music educators become more aware of music-related medical problems as "real" and become increasingly more open to healthier music training,[11,12] injury-preventive education becomes a significant shared interest in both music pedagogy and the medical care profession. Researchers believe that behavioral, environmental, and educational risk factors are manageable, and, consequently, musicians' injuries are preventable.[1,13] At the same time, due to "the complexity and multifactorial etiologies of performance-related disorders," these problems are "too great for either the medical or the artistic community to resolve alone."[14(p135)]

In our study, we were fortunate to collaborate with the University of South Florida's Center for Assistive, Rehabilitation and Robotics Technologies (CARRT), which specializes in using technology to create assistive devices, adaptive equipment, and rehabilitation tools to improve the quality of life for persons with disorders or disabilities.

Risk Factors

Common demographic, behavioral, and environmental risk factors for playing-related pain and injury are age, gender, years of playing, instrument-specific ergonomic problems, poor technique, poor posture, lack of preventive wellness behaviors, previous trauma, the playing load, and noise disturbances.[15–17] Among instruments, brass and woodwinds are among the lower-risk instruments, while string, keyboard, percussion, guitar, and harp are rated as higher risk instruments for injury.[18] In a study that compared non-instrumentalists (n=159) with instrumental music students (n=90), instrumental musicians were found to be two times more likely to have upper-body pain in the shoulder, elbow, and wrist and 50% less likely to have lower-body pain.[19]

Prevention and Intervention

Several studies have focused on the effects of physical exercise programs on injury prevention and intervention,[7,20-23] but few

have investigated their effects on performance efficacy. Musicians' posture, breathing, muscle strengthening and flexibility, and endurance have been the primary interests of these studies.

Posture

The proper alignment of the spinal structure and stabilization of the head, neck, and trunk are the keys to musicians' limb function; the awareness of one's body posture and maintenance of good spinal alignment can be improved by re-educating proprioceptive feedback.[24] Body posture, dynamic somatic practices, and motor control are inherently connected, and kinesthetic re-education, which emphasizes both cognitive and kinesthetic awareness of postural reflexes, can influence a lasting change in the way a person controls body-mind behavior.[25] In one study, musicians were taught to be aware of their non-static posture between movements and trained to monitor varied changing posture and movements during playing an instrument.[23]

Breathing

Proper breathing releases physical tension and allows the muscular coordination to function freely.[24] Undoubtedly, breathing is the most vital physiological factor in all music performance.[26] Particularly, for singers and wind players, breathing is the main source of vocal cord, embouchure, and reed vibration.[27] Even though all living things breathe, efficient breathing is developed through the correct technique and repeated practice.[28,30]

Flexibility, Strengthening, and Endurance Exercises

For musicians, low-resistance, high-frequency strengthening exercises are more suitable than the high-resistance varieties designed to produce muscular mass.[20] Brandfonbrener[20] experimented with two types of exercises. The strengthening exercise group used Thera-Bands, exercise foam, rubber bands, and exercise gloves for finger exercises, while the flexibility group was taught a set of protocols that included warm-up and cool-down stretches. Spahn et al.[21] applied pelvic-lower back-abdominal muscle exercises. Feldenkrais, autogenic training, yoga, the Alexander technique, functional relaxation, Aikido, Shiatsu, and Tae Kwon Do were used in another study.[7]

The Greef et al.[23] study used a set of general conditioning exercises and instrument-specific movement exercises added to warm-up and cool-down phases. Ackermann's[22] exercises were aimed at developing strength and endurance, which included the biceps curl, reverse fly, lateral raise, triceps extension, shoulder forward flexion, bent-over row, back extension, shoulder extension, and opposite shoulder and hip extension, as well as sit-ups, and push-ups.

From the analyses of the above-described literature, we developed an evidence-based theoretical framework (Fig. 1), from which an intervention program and psychometric instruments were developed.

STUDY METHODS

A team that included a music performer/pedagogue/researcher, a biomechanical motion analysis specialist, a physical therapist, and a musician/yogic-breathing teacher collaborated to study the health, work, practice habits, and physical and musical efficacy of college instrumental musicians. Musicians were taught a combined intervention program of yogic-breathing and physical therapy exercises. The self-reported survey (Physical & Musical-Performance Efficacy Assessment Survey, PME) included the measurement of physical efficacy (degree of awareness and comfort about posture, tension, movement flexibility, comfort levels of instrument and repertoire) and musical efficacy (degree of awareness and comfort of technique, tone, and music flow). Data were compared before and after to assess changes.

Hypotheses

1. Intervention with combined yogic-breathing and physical therapy exercises during instrumental training will increase physical efficacy while playing the instrument in college musicians.
2. Intervention with combined yogic-breathing and physical therapy exercises during instrumental training will increase musical-performance efficacy in college musicians.

Intervention Program

Breathing exercises (see Appendix A*) were adopted from the traditional yoga practice[29,30] and Arnold Jacobs' brass-wind pedagogy.[28] These breathing exercises are intended to increase efficiency, endurance, and control of body movements while playing the instrument (Fig. 2).

Physical therapy exercises (see Appendix B*) were carefully selected for the purpose of strengthening the muscles of the core, shoulder, neck, and upper arm and to increase joint flexibility in these regions (Fig. 3).

Subjects

Fifteen instrumental musicians from the school of music at a large research university were recruited to volunteer for the study. The musicians completed the consent form during the orientation meeting (IRB# 107588 G). The criteria for participation were: they must be currently enrolled instrumental performance majors at either the undergraduate or graduate level; agree to attend weekly training (8 weeks) sessions; have no known history of physical problems including scoliosis, organic rheumatoid arthritis, or recent musculoskeletal injury (in the last 6 months); have no history of pulmonary or cardiovascular disease; and agree to complete the Health-Pain-Injury Inventory (HPI) and Physical & Musical Performance Efficacy Assessment Survey (PME) before and after the 8-week training.

* Appendixes A, B, and C, describing the yogic breathing exercises, physical therapy program, and the HPI/MPE are available online on the journal's website: www.sciandmed.com/mppa (see June 2012, Lee).

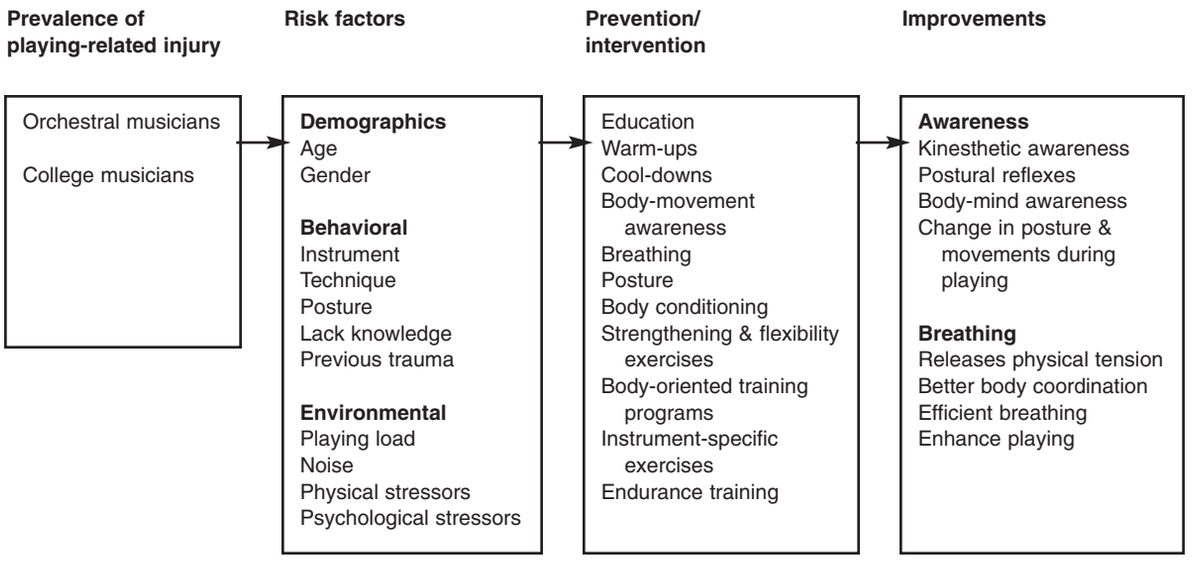


FIGURE 1. Theoretical framework from the literature.

Procedure

Musicians were divided at random into two groups. Each group received 4 weeks of weekly sessions of (1) breathing and 4 weeks of (2) strengthening-flexibility exercises. Group A had breathing sessions first, followed by strengthening-flexibility in the second 4 weeks; group B received the 4-week sessions in the reverse order. Musicians were instructed to practice the exercises daily (20 minutes for each breathing and physical exercise) and turn in a daily exercise checklist at the weekly meeting.

Measurement Instruments

A psychometric instrument was developed for this study by drawing content issues from the theoretical framework. The questions included 4 demographic variables, 23 health inventory variables (HPI), and the 28-item PME survey (see Appendix C*).

Physical efficacy was measured by the degree of "awareness" and "comfortableness" of "posture," "tension," and "flexibility." Music-performance efficacy was measured by the degree of "awareness" and "comfortableness" of "technique," "tone," and "musical flow and fluency." The instrument was pilot-tested and validated by four non-participating graduate musicians and two music professors.

Research Model

Control variables were gender, college enrollment level (freshmen, sophomore, etc), instrument, and career goal(s) (Table 1). Other potential artifacts, such as genetic disposition or anxiety-prone personality vs. more confident-type personality, were not included in this study, as we had no reason to believe that the volunteers are atypical among the musicians in this school and, therefore, that these potential artifacts may have had any significant influence on the outcome.

Independent variables were yogic-breathing and muscle-strengthening and joint-flexibility exercises. Dependent variables were the 23-item health-pain-injury inventory (HPI) and the 28-item physical & musical efficacy indices (PME).

FIGURE 2. Yogic-breathing exercise.

FIGURE 3. Strengthening-flexibility exercise.

TABLE 1. Research Model

Control Variables	Independent Variables	Dependent Variables
Gender College years Instrument Career goals	Yogic-breathing exercises Muscle-strengthening and joint-flexibility exercises	Health-Pain-Injury Inventory (HPI) Physical and Musical Self-Efficacy Survey (PME)

RESULTS

Participating musicians included 6 freshmen, 4 sophomores, 2 juniors, 2 seniors, and 1 master's-level graduate musician; 8 were females and 7 males. Instruments played and career goals are listed in Table 2. We had neither keyboard players nor conductors participating in the study.

The majority of college musicians reported that they were healthy, attended rehearsals and classes regularly, had lots of energy, and slept regular hours (Table 3). However, they said they do not eat well (only 6 "yes" and 9 "no"), nor do they exercise regularly (3 "yes" vs. 12 "no"). Coffee or other caffeine drinks were the only stimulant substance they consume (n = 11). The majority spend less than 10 hrs of non-music-related work (n = 11). Most of the musicians practiced 3 to 4 hrs daily (n = 12), 3 of them practice < 2 hrs daily and none practices >4 hrs. Thirteen of them use warm-up exercises; and 3, a cool-down routine. Most of them are comfortable with their instruments and new repertoire. This inventory reflects a healthy and relatively pain-injury free musician cohort who have good work and practice habits.

Table 4 shows that of the 14 who responded to the questions on pain and injury, only 4 musicians reported having frequent pain, 5 never, 2 once, and 3 sometimes. Only 2 reported having had a music-related injury. The neck and wrist were the most frequently reported locations of pain-injury (6 each), followed by the shoulder and lower back (4 each). Two each report having had pain or injury at the upper arm, forearm, hand, fingers, jaw, and head, and 1 person had a problem with breathing.

On the physical efficacy measure, less than half of the musicians were aware of or comfortable with their posture, tension, or movement flexibility. The remainder reported "usually," "sometimes," or "not at all" (Table 5). However, the musical performance efficacy measure showed the majority as being well aware and comfortable with their musical technique, tone, and fluency in the pre-program survey.

All 15 instrumentalists completed all exercise sessions. However, only 4 end-of-term surveys were collected, partially due to the collection methods. With such a small return of post surveys, a rigor of the comparison before and after the

TABLE 2. Demographic Information for College Musician Sample (n = 15)

	No.
College year	
Freshmen	6
Sophomore	4
Junior	2
Senior	2
Graduate	1
Gender	
Female	8
Male	7
Instrument	
Strings	8
Woodwinds	4
Brass	2
Percussion	1
Keyboard	0
Conducting	0
Career goal	
Teaching	4
Performing	5
Both teaching and performing	5
Other (physical therapy)	1

TABLE 3. College Musicians' Inventory of Health, Work, and Practice Habits (n = 15)

	Yes	No	NR
I am healthy	15	0	
I attend rehearsals and classes regularly	15	0	
I have lots of energy	11	4	
I sleep 6 to 8 hours a day	12	3	
I eat three balanced meals each day	6	9	
I exercise regularly	3	12	
I take allergy medication	2	13	
I smoke cigarette	1	14	
I drink alcohol	6	9	
I drink coffee or other caffeine drinks	11	3	1
I use illegal drugs	1	14	
I do non-music-related work <10 hrs/week	11	NA	
I do non-music-related work about 20 hrs/week	3	NA	
I do non-music-related work > 20 hrs/week	1	NA	
I practice < 2 hours a day	3	NA	
I practice 3-4 hours a day	12	NA	
I practice > 4 hours a day	0	NA	
I begin practice with warm ups	13	2	
I end practice with cool down	3	12	
I am comfortable with my old instrument	8	0	2
I am comfortable with my new instrument	5	NA	
I have new repertoire and am comfortable	8	NA	

NR, no reply; NA, not applicable.

TABLE 4. College Musicians' Pain and Injury Inventory (*n* = 14)

	Never	Once	Sometimes	Often	Very Often
I experience music-related pain	5	2	3	2	2
I've had music-related injuries	10	2	0	0	2
Location of pain and injury (*n*)					
Neck	6	Fingers			2
Shoulder	4	Cheek			0
Upper arm	2	Lips			0
Lower arm	2	Jaw			2
Elbow	0	Headache			2
Wrist	6	Lower back			4
Hand	2	Other: specify & explain			Breathing

program is limited. A few factors illuminate possible effects, nonetheless. Awareness of posture, comfort of posture, and awareness of tension scores increased impressively from pre to post-intervention (from 3.2 to 4; 3.4 to 4.25; and 2.9 to 3.5, respectively), indicating improvement in physical efficacy. Table 6 shows no differences in all other dimensions measured. Two groups eventually merged into one due to difficulty in scheduling sessions, allowing the research team no comparison of the differentiated exercise order.

Qualitative Data

Two musicians provided open-ended comments in the baseline survey and two at the end-of-term survey: "*I play violin and viola and I also see a chiropractor for minor scoliosis, but my pain is now more focused on my shoulder/neck.*" "*I have anxieties about doing this and about other people, but I feel confident that by doing this I will learn to get past those anxieties and feel comfortable at the end of the research sessions*." These pre-survey comments reveal musicians' anxiety in participating in the program. This is something we did not put much thought to in consideration of the study. These comments tell us how important it is to create a safe environment during the orientation meeting and to describe and explain with great detail and effort to make this experience anxiety-free and enjoyable to the participating musicians.

Comments from the post-survey showed a positive experience of the program: "*I definitely feel more relaxed and focused after the breathing exercises, but I have not noticed benefits from the physical therapy exercises*." "*The breathing exercises are great to calm nerves in any situation, allowing for a better, or at least [more] comfortable, performance. The physical exercises are excellent and helped to not only become more aware of my posture, but to be aware of what was wrong.*" This coincides with our numerical data that the intervention program had positive effects on physical efficacy.

MOTION ANALYSIS

Studies that used motion analysis to examine musician subjects have reported varying degrees of wrist and elbow movements, understandably as instrumentations of the studies varied.[31–33] Forearm and wrist motions, integral to many

TABLE 5. College Musicians' Inventory of Posture, Tension, and Movement Flexibility and of Technique, Tone, and Music Flow (*n* = 15)

	Always	Most of the time	Usually	Sometimes	Not at all
Posture, Tension, and Movement Flexibility					
I am aware of my posture	3	3	4	4	1
I am comfortable with my posture	3	4	5	2	1
I am aware of tension in my body	2	3	4	4	2
I am comfortable with tension in my body	1	0	7	3	4
I am aware of my movement flexibility	2	2	6	4	1
I am comfortable with my movement flexibility	1	4	6	2	2
Technique, Tone, and Music Flow					
I am aware of my technique	4	8	2	1	0
I am comfortable with my technique	1	6	6	1	1
I am aware of my tone	10	4	0	1	0
I am comfortable with my tone	2	10	2	1	0
I am aware of music flow/fluency	6	7	1	1	0
I am comfortable with music flow	2	8	3	2	0

TABLE 6. College Musicians' Physical and Musical Awareness and Comfort Before and After Intervention Exercises

	Before (n = 15)	After (n = 4)
Music-related pain	3.42	3.5
Music-related injury	4.28	4.75
Awareness of posture	3.2	4
Comfort of posture	3.4	4.25
Awareness of tension	2.9	3.5
Comfort of tension	2.4	2.5
Awareness of movement flexibility	2.8	2.75
Comfort of movement flexibility	3	3
Awareness of technique	3.75	
Comfort of technique	3.3	3
Awareness of tone	4.5	3
Comfort of tone	3.63	3.5
Awareness of music flow/fluency	4.2	3.75
Comfort of music flow/fluency	3.43	3.2

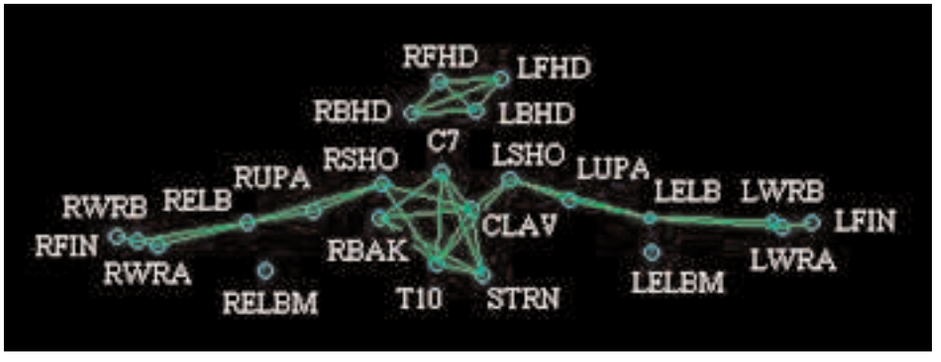
activities of daily living (ADL), reported by Carey et al.,[34] provide pronation-supination angular motion of about 160° in the transverse plane and the wrist flexion and extension of about 150° as well as some radio-ulnar deviation in the frontal plane. Palmer et al.[35] report more modest articulation required for ADL (5° flexion, 30° extension, 10° radial deviation, and 15° ulnar deviation), while Ryu et al.[36] reported 40° of wrist flexion and extension as well as 10° of radial deviation and 40° of ulnar deviation during ADLs. Clearly, each instrumentalist's movements need to be examined individually and specifically to the techniques required to play the music selected.

Subjects

Two college instrumental musicians, both undergraduates, a flutist and a cellist, were recorded while playing their instrument in the USF CARRT's motion analysis laboratory to assess if there were changes before and after the 8-week experimental period of practicing breathing and therapeutic exercises.

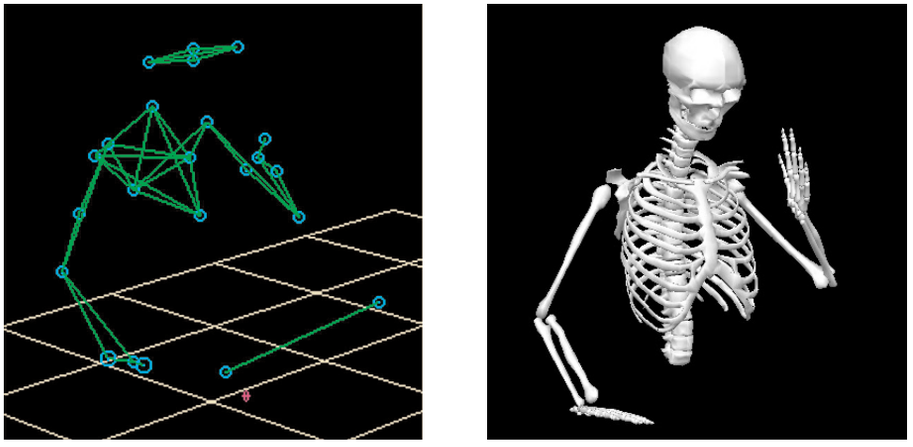
Experiment Setup

An eight-camera Vicon™ motion analysis system (Vicon, Oxford, UK) in conjunction with two AMTI (Watertown, MA) multi-axis force plates were used to collect (120 Hz) and analyze movement data while the musicians played the instrument. The subject playing the flute was asked to keep one foot on each force plate throughout each trial, allowing each force plate to record its respective ground reaction force (GRF) separately. GRFs in the vertical direction (Fz) were recorded in Newtons (N). Prior to data collection, a calibration procedure was conducted according to the manufac-



Marker	Name
LFHD, RFHD	Left, Right front head
LBHD, RBHD	Left, Right back head
LSHO, RSHO	Left, Right shoulder
LUPA, RUPA	Left, Right upper arm
LELB, RELB	Left, Right lateral elbow
LELBM, RELBM	Left, Right medial elbow
LWRA, RWRA	Left, Right lateral wrist
LWRB, RWRB	Left, Right medial wrist
LFIN, RFIN	Left, Right 3rd metacarpal
CLAV	Jugular notch where clavicles meet
STRN	Xiphoid process of the sternum
C7	Spinous process of 7th cervical vertebrae
T10	Spinous process of 10th thoracic vertebrae
RBAK	Right back asymmetrical marker

FIGURE 4. Vicon motion analysis markers.



Vicon view Visual 3D view

FIGURE 5. Graphical representation of cello player, showing Vicon motion analysis markers and skeletal view with Visual 3D software.

turer's guidelines. A standard digital video camera was also used to film digital video of the subjects.

Each musician played a set of scales twice and a short musical excerpt before and after the exercise program. Wrist, elbow, and shoulder angles were calculated using Visual 3D software (C-motion, Germantown, MD). Figure 4 shows all the markers. Figure 5 shows a graphical representation of the cellist both in the Vicon view as well as a skeletal view from the Visual 3D software.

Results

Figure 6A (right bowing arm) and 6B (left neck arm) show the range of motion of the wrist, elbow, and shoulder of the cellist playing a scale before and after the 8-week intervention program. After intervention, the cellist showed increased ranges of motion.

Figure 7 shows the shoulder abduction and adduction of the bowing arm over the entire length of sample trials of the cellist playing scales before and after the intervention program.

The vertical ground reaction forces (Fz) of the flutist playing scales before and after are shown in Graph 8A and 8B, respectively. The flute player did not move much in the upper body. However, our subject shifted the body weight from one foot to the other more in the second playing than in the pre-training one.

Discussion on Motion Analyses

Our resident cello professor's observation was that this student has excellent posture and bowing arm, and the larger motion at the shoulder with smaller motion at the elbow indicates possibly increased expression and freedom in playing. This change can be attributed to the increased physical efficacy, i.e., awareness and comfort of body posture and body tension.

The flute player did not move much in the upper body. In consultation with the resident flutist-professor, we learned that it is desirable for flutists to move the upper body minimally in order to maintain the balance of breathing and control of tone production. The flute player shifted her body weight from one foot to the other more after the intervention, as shown in the increased ground reaction forces. This may also be due to the increased physical efficacy that allowed more freedom to express her musicality.

With two case samples of different instruments, our primary purpose was to explore the possibility of collecting kinematic and kinetic data with a motion analysis system during instrument playing. The study imparted instrument-specific kinematics to study; the pre- and post-intervention data can help to determine the effects of the exercise in a meaningful way for expert pedagogy.

SUMMARY AND DISCUSSION

The findings of the study are summed up in the following:

- College musicians in this sample had a healthy working and living style but insufficient eating and exercise habits.
- College musicians in this sample were not well aware of their bodily posture, tension, and movement flexibility, but they were well aware of and comfortable with their music production including technique, tone, flow, and repertoire.
- There were no differences between self-reported pre and post assessments in college musicians' pain and injury and musical-performance efficacy (awareness and comfort of music performance).
- The combined breathing and strengthening/flexibility exercise program showed increased physical efficacy (awareness and comfort of posture and awareness of tension).
- Motion analysis data of two musicians showed changes from the pre- to post-intervention program, coinciding with the improvement in physical efficacy.

The experiment indicates motion analysis to be a feasible measurement tool to study effects of training for instrumen-

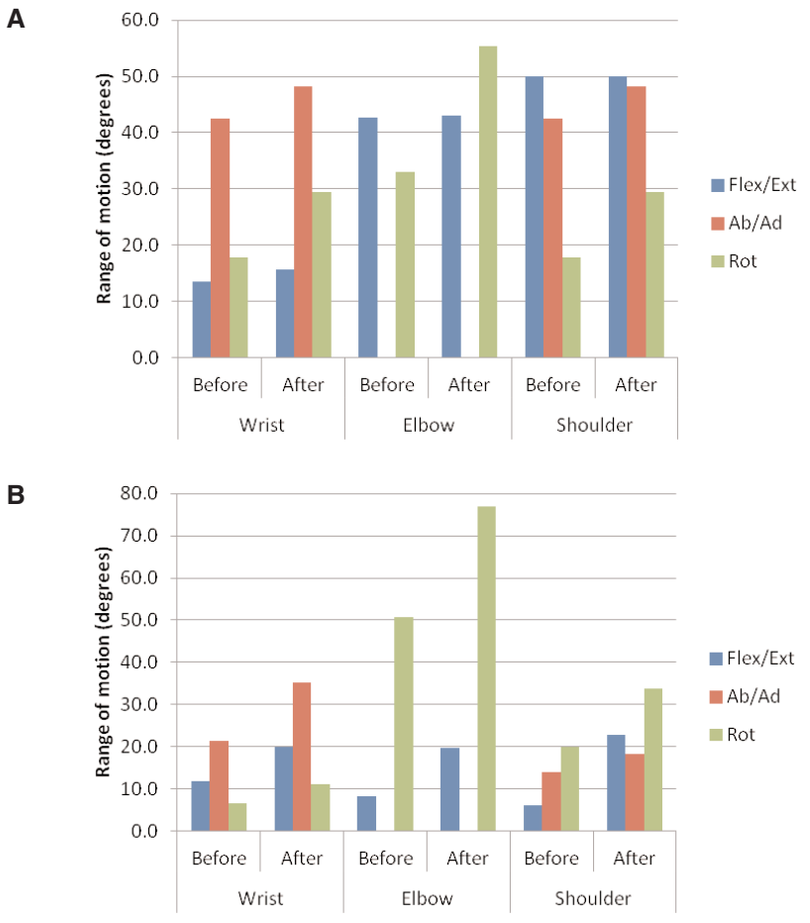


FIGURE 6. A, Range of motion of bowing arm before and after intervention program. B, Range of motion of left neck arm before and after intervention program.

tal musicians. We expect to further explore the use of motion analysis as a viable training, injury prevention, and rehabilitation tool for instrumentalists.

This study gave an enlightening experience to the researchers. First, we are pleased to validate the combined breathing and strengthening/flexibility exercises and to know that they are well received by our college musicians. We echo Brandfonbrenner's experience[2] that the feasibility of such an education program in college musicians' busy lives is unrealistic. We often met on Sunday nights to accommodate the musicians' schedules. Weekday evenings are normally occupied with rehearsals and practices. The voluntary end-of-

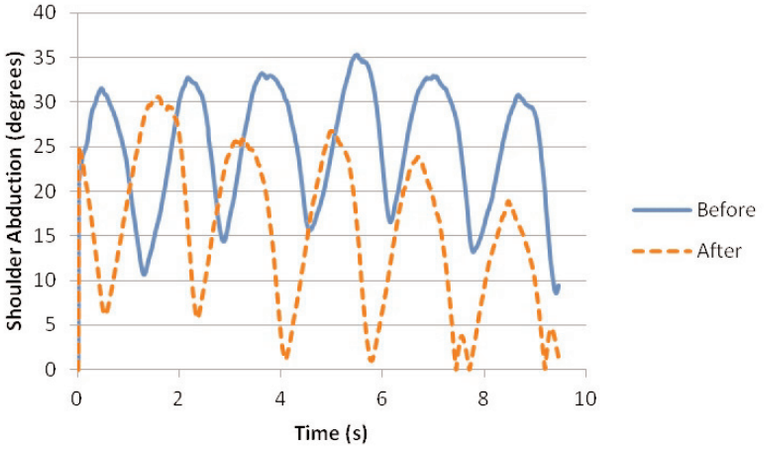


FIGURE 7. Shoulder abduction of the bowing arm of cellist while playing scales before and after intervention program.

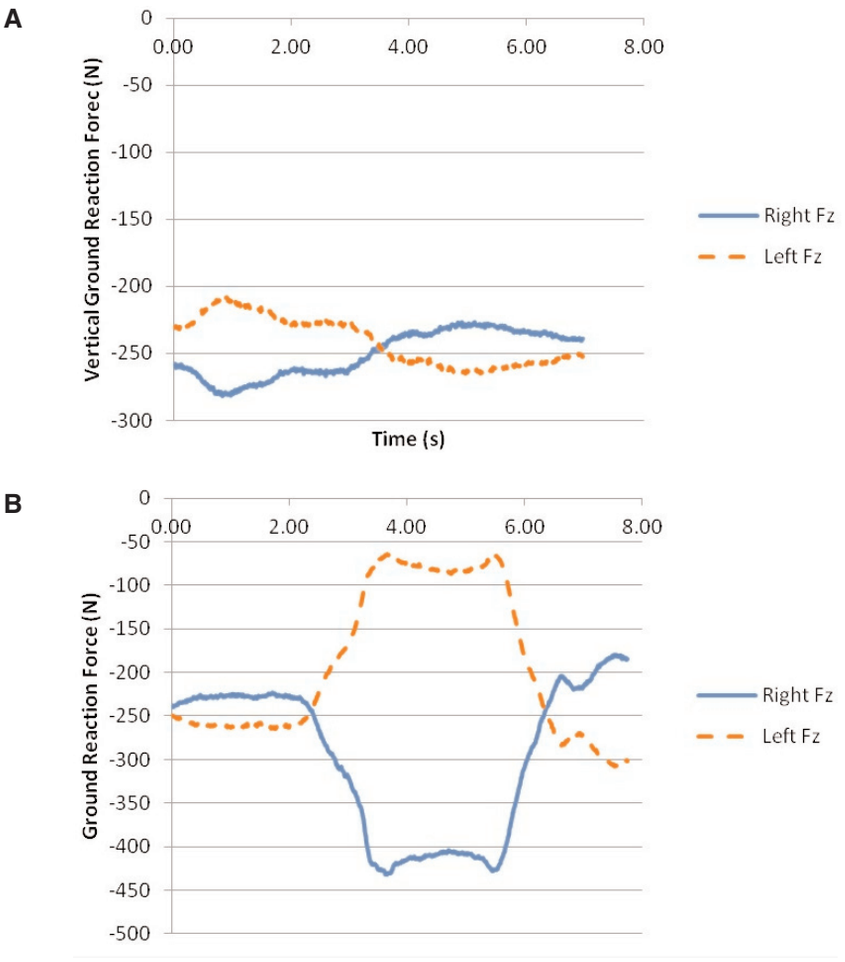


FIGURE 8. Vertical ground reaction force (Fz) from right and left side of flutist while playing a scale before (panel A) and after (panel B) intervention program.

term data collection was difficult and was perhaps not realistic either. The small number of post-program data is not a reflection of attrition, but an oversight of survey distribution during the last session; the program had full attendance throughout. Our future plan is to incorporate the program into a performance education course (currently in progress).

Simple data descriptions allow a close look at the characteristics of this group as a case study, and the comparison of data before (n = 15) and after (n = 4) the intervention program. A caveat in such a small set comparison is that these four musicians might be among the highest raters in the initial survey as well. Factor analysis and Cronbach's alpha (validity and reliability tests), ANOVA (group comparison), ANCOVA (control of group effects), and multiple regression analysis (prediction and explanation) require larger sample data; we plan to continue to accumulate data in multiple years and multiple sites using the same protocol and hope to generate a large enough data set to retest these pilot findings. Recent presentation at the PAMA 2011 symposium resulted in arrangements for future collaborations at national and international sites to replicate the study among college instrumentalists. We anticipate robust data and outcome from the international multi-site study.

We acknowledge the contribution of Mathew Lazinski, MS, OTS, PT, who developed the set of muscle strengthening and flexibility exercises and conducted the Sunday evening sessions for our participating instrumentalists.

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* Appendixes A, B, and C, describing the yogic breathing exercises, physical therapy program, and the HPI/MPE are available online on the journal's website: www.sciandmed.com/mppa (see June 2012, Lee).

APPENDIX A

Yogic Breathing Exercises for Musicians
Developed by Rachel Matz

The following exercises are taken from the yogic art of breathing, the pranayama, and have been modified for the needs of wind players as taught by Arnold Jacobs. The goals of these exercises are to gain better control and efficiency of breathing, and to help musicians relax and focus to produce better performance results.

For the purposes of this research, please practice these exercises **before** you play for the first time every day. Please read all directions before beginning. The complete exercise will take 10 minutes once you become familiar with the procedure.

Before you start:

1. Sit erect.
2. Keep feet flat on the floor, pointing forward and parallel to each other.
3. Roll shoulders forward, up, and then back and down.
4. Close your eyes for a moment, and feel your weight sink down into your seat.
5. Set a metronome to 60 bpm. This will be the tempo for all exercises.
6. Do no use force—breathing is natural. Be conscious of how your body feels.
7. Form the syllable "OH" or "HOH" in your mouth before beginning. Be sure to consciously reset your mouth every time you start a new exercise.
8. Remember, "Breathe to expand; do not expand to breathe." —Arnold Jacobs
9. Some of these exercises may be challenging if you are new to breathing exercises. You may not be able to perform all of the exercises at first, and that is fine. Only go as far as you are comfortable with. If you feel discomfort or dizziness during any of the exercises, take a break, and resume once you feel normal again. (*Tip*: Jumping up and down helps get rid of dizziness.)

Exercises 1 through 4: Breathing in sections and the "Complete Breath"

Imagine that your lungs are divided into three sections: upper, middle and lower. For each position, breathe in for 4 counts and out for 4 counts. Do this 4 times per position. This will help you realize your full capacity.

1) *Ahdi mudra* (upper chest): Place your hands flat upon the tops of your upper thighs, fingers pointing inwards. Relax your elbows. In this position, you can only breathe from your upper chest. You will observe your chest rising and falling and your upper ribcage expanding.
2) *Chinmaya mudra* (middle chest): Form a ring with the index finger and thumb, and curl the other fingers into the palm. Place your hands on top of your thighs again. In this position, you can only breathe from your middle chest. You will observe the middle part of your chest and lower ribs expanding, like you have an inner tube around the middle of your torso.
3) *Chin mudra* (lower chest): Form a ring with the index finger and thumb, leaving the other fingers stretched and together. Place your hands on top of your thighs again. In this position, you can only breathe from your lower chest. You will feel the part of your abdomen below your ribcage expand.
4) *Dirgha* ("complete breath"): Fill all three sections of the lungs, starting from the bottom and working up. Keep hands in the position for chin mudra.

IMPORTANT: The Dirgha is the breath we will use for the remaining exercises

Take a 1–2 minute break before the next exercise.

Exercises 5 and 6: Breathing in ratios using the *Dirgha*, filling bottom to top

Tip: Make benchmarks for yourself when performing the following two exercises. For instance, when breathing in for 10 counts, realize that you should be halfway full by count 5. In this manner, you will take a breath that is even all the way through.

5) Ratio 1:1
   Breathe in for 4, and out for 4. Do this 4 times.
   Breathe in for 8, and out for 8. Do this 2 times.
   Breathe in for 16, and out for 16. Do this 1 time.
   Breathe in for 24, and out for 24. Do this 1 time.
   Take a 1–2 minute break, if needed.

6) Ratio 1:2
   Breathe in for 5, and out for 10. Do this 2 times.
   Breathe in for 10, and out for 20. Do this 1 time.
   Breathe in for 15, and out for 30. Do this 1 time.
   Breathe in for 20, and out for 40. Do this 1 time.

APPENDIX B

Muscle-Strengthening and Joint-Flexibility Exercises for Musicians
Developed by Matthew Lazinski

The following exercises are designed to help train and change a forward head and rounded shoulder (thoracic kyphosis) posture. In this posture, potential muscle impairments decrease flexibility of scalene and suboccipital muscles; also, elevated scapulae and improper upper trapezius recruitment patterns are often present. Additionally, the head is forward from it proper resting position causing over recruitment of posterior cervical musculature structures.

Exercises for cervical retraction—The patient is to lift the head up and in, keeping the head level, as they straighten the spine. The patient is to stare at an object in order to keep the head level, and not allow excessive cervical flexion and extension. This movement causes flexion at the upper cervical spine and extension of the lower cervical spine in order to achieve a more ideal cervical-thoracic posture.

Resisted scapular retraction, resisted chest pull—The patient retracts the inferior angle of the scapula against resistance, with the feeling of pinching the shoulder blades (scapula) together. The patient does not extend the shoulders or elevate the scapula in anyway. This exercise allows for increased alignment and recruitment of the scapular muscles in shoulder motions, and it also increases the strength of the rhomboid and middle trapezius muscles.

Pectoralis stretch—This exercise is completed to stretch a shortened pectoralis muscle that is commonly seen with a rounded shoulder posture. This helps release the muscle and allow the shoulders to attain an optimal postural alignment. The patient is standing facing a corner, arms in a reverse T position, elbows and arms against the wall. The body leans into the corner from the ankles until a slight stretch is felt.

Composite upper extremity stretch—This stretch is performed to stretch the shoulder extensors, elbow flexors, and wrist and finger flexors. These muscles are commonly found to be shortened in musicians playing in these postures for extended periods of time.

The following exercise is utilized to help with postural low back pain. This increases proprioception awareness as well as pelvic mobility.

Pelvic clock—In a hook-lying position, you gently contract the abdominal musculature and allow your abdomen to tip toward the 12 of a clock (cephalad), and then contract your lower abdominal muscles so that your pelvis tips toward "6 o'clock" (caudal). These positions are held for 3–5 seconds.

APPENDIX C
College Instrumental Musician Questionnaire
Health-Pain-Injury Inventory (HPI)
Physical-Functional & Musical-Performance Efficacy Assessment Survey (PME)

Introduction

College Instrumental Musician Questionnaire is a self-assessment instrument that is intended to measure the effects of the intervention program on your music-related health conditions and music performance efficacy. There are three parts to this survey: demographic information, the Health-Pain-Injury Inventory (HPI), and the Physical-Functional & Musical-Performance Self-Efficacy Assessment Survey (PME).

Completing this survey will take 15 minutes of your time. Skip any item(s) that you may feel uncomfortable answering. Your survey information will be kept confidential; data will be assembled, analyzed, and reported anonymously.

Part 1: Demographic information about you:

1) Year of university enrollment
   - Freshman _____
   - Sophomore _____
   - Junior _____
   - Senior _____
   - Graduate _____

2) Gender
   - Female _____
   - Male _____

3) Instrument group
   - Strings _____
   - Woodwinds _____
   - Brass _____
   - Percussion _____
   - Keyboard _____
   - Conductors _____

4) Career goal (Check all that apply)
   - Teaching _____
   - Performing _____
   - Other _____
   - Specify _____

Part 2: Health-Pain-Injury Inventory (HPI):

5) How do you assess your general health?

	Yes	No
a) I am healthy	1	2
b) I attend rehearsals and classes regularly	1	2
c) I have lots of energy	1	2

6) How are your general health habits?

	Yes	No
a) I sleep 6 to 8 hours a day	1	2
b) I eat balanced three meals a day	1	2
c) I exercise regularly	1	2

7) How is your medication/substance use?

	Yes	No
a) I take allergy medication	1	2
b) I smoke cigarette	1	2
c) I drink alcohol	1	2
d) I drink coffee or other caffeine drinks	1	2
e) I use illegal drugs	1	2

8) How are your time constraints due to non-music-related work? (Check one)
   - a) I work less than 10 hours a week _____
   - b) I work about 20 hours a week _____
   - c) I work more than 20 hours a week _____

9) How is your music practice habit? (Check one)
   - a) I practice less than 2 hours a day _____
   - b) I practice 3 or 4 hours a day _____
   - c) I practice more than 4 hours a day _____

10) How is your practice routine?

	Yes	No
a) I begin practice with warm ups	1	2
b) I finish with warming down	1	2

11) Are you comfortable with your instrument? (Choose one, a or b)

	Yes	No
a) My instrument is old, but I am comfortable	1	2
b) I have a new instrument but I am comfortable	1	2

12) Are you comfortable with your repertoire?

	Yes	No
a) I am working on the same piece(s)	1	2
b) I have a new piece	1	2

Part 3: Physical-Functional & Musical-Performance Efficacy Assessment Survey (PME)

13) How is your music-related pain and injury?

	Very often/	Often/	Sometimes/	Once/	Never
a) I experience music-related pain	1	2	3	4	5
b) I've had music-related injury	1	2	3	4	5

14) Where is your pain and injury? (Check all that apply)

a) Neck _____
b) Shoulder _____
c) Upper arm _____
d) Lower arm _____
e) Elbow _____
f) Wrist _____
g) Hand _____
h) Fingers _____
i) Cheek _____
j) Lips _____
k) Jaw _____
l) Headache _____
m) Lower back _____
n) Other _____
Specify and explain _____

15) How aware are you about your body function when you play your instrument?

	Not at all/	Sometimes/	Usually/	Most of the time/	Always
a) My posture	1	2	3	4	5
b) Tension in my body	1	2	3	4	5
c) Movement flexibility	1	2	3	4	5

16) How comfortable are you with your body movement as you play your instrument?

	Not at all/	Sometimes/	Usually/	Most of the time/	Always
a) My posture	1	2	3	4	5
b) Tension in my body	1	2	3	4	5
c) Movement flexibility	1	2	3	4	5

17) How aware are you about your musical technique and sound when you play your instrument?

	Not at all/	Sometimes/	Usually/	Most of the time/	Always
a) My technique	1	2	3	4	5
b) Tone	1	2	3	4	5
c) Musical flow and fluency	1	2	3	4	5

18) How comfortable are you about your musical technique and sound when you play your instrument?

	Not at all/	Sometimes/	Usually/	Most of the time/	Always
a) My technique	1	2	3	4	5
b) Tone	1	2	3	4	5
c) Musical flow and fluency	1	2	3	4	5

19) Please feel free to write any remarks including apprehension, anxieties, satisfaction, and any other experience about this study.