Effect of Table Trainer–to-Student Ratios on Outcome in Student Assessments of Cervical Muscle Energy Techniques

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Context: Improving the acquisition of osteopathic manipulative treatment (OMT) skills may increase student confidence and later use of OMT. A first step in this process is determining the optimal table trainer–to-student ratio (TTR).

Objective: To determine the effect of TTR on knowledge and skill acquisition of cervical muscle energy OMT techniques in first-year osteopathic medical students.

Methods: First-year students at 3 colleges of osteopathic medicine received instruction on cervical diagnosis and muscle energy techniques at 1 of 3 workshops, each having a different TTR (1:4, 1:8, or 1:16). Written assessments were conducted immediately before and after the workshop and again 2 weeks later to test retention of the knowledge acquired. Practical assessments were conducted immediately after the workshop and 2 weeks later to test retention of the skills acquired and were graded for technical and proficiency elements.

Results: Ninety-two students completed pre- and postworkshop assessments, and 86 completed the retention assessment. No difference was found between TTRs on the preworkshop, postworkshop, and retention written scores ($P \geq .15$). Postworkshop written assessment scores were highest, followed by retention scores; preworkshop scores were lowest ($P < .001$). Although the mean (SD) postworkshop practical scores for the 1:4 and 1:8 TTR workshop groups (266.3 [43.1] and 250.6 [47.5], respectively) were higher than those for the 1:16 TTR groups (230.3 [62.2]), the difference was not significant ($P = .06$). For the retention practical assessment scores, no significant difference was found between TTRs ($P = .19$). A significant interaction was noted between TTR and the timing of practical assessments; scores declined from postworkshop to retention assessments for the 1:4 ($P = .04$) and 1:8 ($P = .02$) TTR workshop groups but not the 1:16 TTR workshop groups ($P = .21$). Student order in paired student demonstrations also had a significant effect on technical scores ($P \leq .03$); students who demonstrated techniques second had higher scores than those who demonstrated techniques first.

Conclusion: The TRR had no significant effect on written or practical assessment scores. Practical assessment scores for the 1:4 and 1:8 TTRs declined significantly between postworkshop and retention assessments. Future studies with more statistical power will be necessary to determine the effect of TTRs on student learning. The current study also found that student order in paired demonstrations may affect practical assessment scores, because the second-demonstrating student scored higher than the first; colleges of osteopathic medicine should therefore consider randomizing student order during practical assessments.

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The goal of first-year and second-year curricula at colleges of osteopathic medicine (COMs) is to establish foundational knowledge in osteopathic manipulative medicine (OMM) that students can build on during clinical training in their third and fourth years. However, studies[1-4] have shown that the use of osteopathic manipulative treatment (OMT) declines as students progress through osteopathic medical school and postgraduate training. A survey of fourth-year students showed that nearly 20% reported lack of confidence in OMT skills as the primary reason for not using OMT during their clerkships.[5] The surgical literature[6-8] suggests that confidence in procedural skills after educational interventions is directly related to competence in those skills. One factor that may affect student skill development during the first- and second-year OMM curricula is the number of instructors, or table trainers, available to assist students as they practice the techniques presented in class. For school accreditation, most health care–related fields require a minimum instructor-to-student ratio for the psychomotor skills portions of curricula.[9,10] However, because COM accreditation guidelines do not specify a required instructor-to-student ratio for OMM training, the number of table trainers, and thus the table trainer–to-student ratio (TTR), varies widely among COMs.

Cervical muscle energy OMT techniques are taught at every COM in the United States. Muscle energy is one of the top 5 OMT techniques used on the Comprehensive Osteopathic Medical Licensing Examination-USA (COMLEX-USA) Level 2-Performance Evaluation.[11] Thus, investigating cervical muscle energy techniques, as taught in a workshop format to first-year osteopathic medical students, may be appropriate for determining TTRs for learning OMM. To assess OMT knowledge and skill acquisition, COMs primarily use written and practical assessments.

The current study determined the effect of TTR on knowledge and skill acquisition of cervical muscle energy techniques in first-year osteopathic medical students using preworkshop, postworkshop, and retention written assessments and postworkshop and retention practical assessments. We hypothesized that students in groups with lower TTRs would score significantly higher on postworkshop and retention assessments, as well as have notably greater improvement in pre- to postworkshop assessment scores, than students in groups with higher TTRs.

Methods

In fall 2013, first-year osteopathic medical students were recruited by e-mail and OMM classroom announcements at 3 participating COM study sites—the New York Institute of Technology College of Osteopathic Medicine in Old Westbury, the Rowan University School of Osteopathic Medicine in Stratford, New Jersey, and the University of North Texas Health Science Center Texas College of Osteopathic Medicine in Fort Worth—to participate in a 1-hour workshop on cervical muscle energy OMT techniques outside the normal OMM curriculum. Students could choose 1 of 3 possible workshops based on availability. Informed consent was obtained from each student at the beginning of each workshop. Students who had previously been instructed in cervical spinal segmental diagnosis and muscle energy or high-velocity, low-amplitude treatment were excluded. Because students functioned as simulated patients for their fellow participants, students with acute torticollis, acutely herniated cervical disks, or history of cervical spine surgery that could alter the normal functional anatomy of the cervical spine were also excluded. The current study was reviewed and approved by the institutional review board at each participating COM.

Workshops

Each cervical muscle energy workshop had a different TTR (1:4, 1:8, or 1:16). Students were blinded to the

TTR of their chosen workshop until the time of the workshop. Workshops were timed to occur before scheduled OMM curricular training on cervical spinal segmental diagnosis and cervical muscle energy techniques so that students were unfamiliar with the content of the workshops. Each workshop included a prerecorded, combined PowerPoint (Microsoft) and video presentation on segmental diagnosis of the typical cervical spine (spinal levels C2-C7) and treatment with direct muscle energy techniques. Under the tutelage of the table trainers, students practiced the skills presented in the video on a randomly assigned fellow participant.

Before the workshop, a written assessment was administered to assess baseline knowledge. At the end of the workshop, students completed written and practical assessments of the material to determine their immediate acquisition of knowledge and skills during the workshop. Two weeks later, they repeated the written and practical assessments to determine their retention of knowledge and skills. The table trainers at each participating COM study site viewed the video presentation before the workshop but were blinded to the content of the written and practical assessments. Students were given a paper copy of the PowerPoint presentation at their workshop.

Written Assessments

The 3 written assessments—preworkshop, postworkshop, and retention—tested baseline knowledge, immediate knowledge acquisition, and knowledge retention, respectively. These assessments consisted of 10 COMLEX-USA–style, multiple-choice, case-based items that assessed knowledge of cervical segmental diagnosis (3 items), muscle energy treatment steps appropriate for a specific cervical diagnosis (4 items), general principles of muscle energy technique (2 items), and musculoskeletal anatomy of the cervical spine (1 item); 3 items in each assessment assessed higher-order reasoning. All 3 written assessments included the same number of items in each category, but the items were different for each assessment. The students recorded their answers on scannable forms, which were returned to the principal investigator for scoring. One point was awarded for each correct answer, for a possible maximum of 10 points. Scores were also calculated for the 4 categories and for the higher-order reasoning items.

Practical Assessments

The 2 practical assessments—postworkshop and retention—assessed immediate skill acquisition and retention, respectively. These assessments consisted of student verbalization and demonstration of 2 cervical muscle energy techniques to treat 2 fictitious cervical vertebral somatic dysfunction diagnoses. The students were randomly assigned a partner, and the technique demonstration order was randomly assigned for each pair of students. The 2 students in each pair were assigned different, but equivalent, cervical somatic dysfunction diagnoses. The practical assessments were digitally recorded using audio and video. Up to 8 students underwent their practical assessment simultaneously, and all students received the same standardized instructions. Including the delivery of instructions and demonstration of the 2 techniques, each practical assessment lasted 6 minutes.

The video-recorded practical assessments were graded by 11 faculty members who were experienced at grading cervical muscle energy practical examinations and who were from COMs other than the study sites. Graders were blinded to the participant's name, study site, workshop TTR, student order, and timing of the assessment (postworkshop or retention). The 2 cervical muscle energy techniques performed during each practical assessment were evaluated separately for technical and proficiency elements according to a 300-point scoring rubric (*Table 1*), which included a criteria score for the technical performance of the muscle energy technique (eg, hand position, number of repetitions) and a proficiency score for the quality of the performance (eg, control, accurate verbal explanation of instructions and steps). This scoring system is used at several COMs and has been used by the American Osteopathic Board of Neuromusculoskeletal Medicine for more than a decade. The criterion score included 15 elements, each with a possible score of 2 points, for a maximum score of 30 points. The proficiency score included 16 elements, with deductions from an initial score of 10 ranging from –0.2 to –5.0 points, for a maximum deduction of 10 points. The criterion score was multiplied by the proficiency score for a maximum practical assessment score of 300 points.

Statistical Analysis

For descriptive statistics, means and SDs were used to summarize the preworkshop, postworkshop, and retention written and practical assessment scores. Fisher exact tests were used to compare the TTR groups on the dropout rates for the retention assessments. Friedman tests were used to compare scores between preworkshop, postworkshop, and retention written assessments. Stratified (by study site) and nonstratified Kruskal-Wallis tests were used to compare preworkshop written assessment scores between TTR groups and between study sites, respectively. Stratified (by study site) and nonstratified nonparametric analysis of covariance, covarying on preworkshop scores, was used to compare postworkshop and retention written assessment scores between TTR groups and study sites, respectively. General linear mixed models were used to test for the effect of TTR, timing of the assessment, study site, and student order within the practical assessment on the practical assessment score. A stratified Spearman correlation was used to assess the relationship between the written and practical assessment scores. The data were analyzed using SAS statistical software (version 9.3; SAS Institute Inc). Differences were considered statistically significant at $P \leq .05$.

Table 1.
Criteria and Proficiency Score Rubrics for Grading Cervical Muscle Energy Techniques in Practical Assessments[a]

Grading Elements

Criteria Score	Score[b]
1. Physician monitors correct location	0, 1, or 2
2. Technique setup position correct for flexion/extension	0, 1, or 2
3. Technique setup position correct for sidebending	0, 1, or 2
4. Technique setup position correct for rotation	0, 1, or 2
5. Physician's hand position correct	0, 1, or 2
6. Clear/concise instructions to patient	0, 1, or 2
7. Direction of patient's contraction correct	0, 1, or 2
8. Isometric resistance applied by physician	0, 1, or 2
9. Contraction held for 3-5 s	0, 1, or 2
10. Relaxation sustained for 1-2 s between contractions	0, 1, or 2
11. Repositions after contraction	0, 1, or 2
12. Repositions to the correct degree	0, 1, or 2
13. Repeats contraction at least 3 times[c]	0 or 2
14. Passive stretch after last contraction/relaxation	0, 1, or 2
15. Reassesses	0, 1, or 2
Proficiency Score	**Deduction[b]**
1. Patient position incorrect	−0.6
2. Physician position awkward or incorrect	−0.6
3. Tentative or poor contact with patient's head or neck	−0.6
4. Tendency to show hesitation	−0.2
5. Poor control or balance of patient's head	−0.6
6. Rough handling	−2.0
7. Wrong cervical segment treated (±2 cervical segments)[d]	−1.8
8. Inaccurately verbalizes setup	−0.2
9. Inaccurately verbalizes patient instructions	−0.2
10. Inaccurately verbalizes relaxation	−0.2
11. Inaccurately verbalizes reassessment	−0.2
12. Inaccurate verbalization of any step is verbally self-corrected	−0.2
13. Receives prompts from partner	−0.8
14. Dangerous maneuver	−5.0
15. Foul language	−2.0
16. Other poor efficacy or other inefficiency	−1.0

[a] The final practical assessment score was calculated by multiplying the criterion and proficiency scores for a maximum score of 300 points. The maximum criterion score was 30 points, and the initial proficiency score, before deductions, was 10 points.
[b] Negative values represent deductions.
[c] No partial credit was given for this element. If the student repeated the contraction 3 or more times, he or she received a score of "2". If the student repeated the contraction less than 3 times, he or she received a score of "0".
[d] Deduction was given if the student demonstrated the assigned technique on a vertebra that was more than 2 vertebral segments away from the assigned vertebra.

Results

Ninety-two students (28 in 1:4 TTR, 32 in 1:8 TTR, and 32 in 1:16 TTR workshop groups) completed the pre- and postworkshop assessments, and 86 students (27 in 1:4 TTR, 31 in 1:8 TTR, and 28 in 1:16 TTR workshop groups) completed the retention assessment. Because of recruitment issues, 1 COM did not have a 1:16 TTR workshop group. Dropout rates were 4%, 3%, and 13% for the 1:4, 1:8, and 1:16 TTR groups, respectively (P=.36). Written assessment scores were significantly related to the timing of the assessments (P<.001) (*Table 2*); postworkshop scores were highest, followed by retention scores; preworkshop scores were lowest. The TTR had no significant effect on any of the written assessment scores (P≥.15).

The preworkshop written assessment scores differed significantly between study sites (P<.001) (*Table 3*). After preworkshop scores were accounted for, no significant differences were found between study sites for postworkshop or retention written assessment scores (P≥.62). Within each study site, written assessment scores were significantly related to the timing of the assessments, consistent with results when all study sites were combined (P<.001).

A total of 173 techniques were scored for the postworkshop practical assessment, and 164 for the retention practical assessment; 11 techniques for the postworkshop and 8 for the retention practical assessments were not graded because of technical errors in the digital recording process. A significant interaction was found between TTR and timing of the assessment (P=.02) (*Table 4*). Practical assessment scores declined from postworkshop to retention assessments for the 1:4 and 1:8 TTR workshop groups (P≤.04) but not the 1:16 TTR groups (P=.21). Although it was not statistically significant (P=.06), the data suggested a difference between TTRs for the postworkshop practical assessment, where the mean score for 1:4 TTR students was 19 points higher than that for 1:16 TTR students. No significant difference was noted between TTRs for the retention assessment scores (P=.19).

The order in which students demonstrated the cervical muscle energy techniques (ie, whether they demonstrated the techniques first or whether they demonstrated after their partner) had a significant effect on criterion scores for both practical assessments (P≤.03) (*Table 5*); students who demonstrated the techniques second in their pair scored higher than those who demonstrated the techniques first. Student order also had a significant effect on the final score for the postworkshop practical assessment (P=.003) but not the retention assessment (P=.28); students who demonstrated second scored higher on the postworkshop assessment than those who demonstrated first. Student order had no significant effect on proficiency scores for either practical assessment (P≥.13). Analyzing first- and second-demonstrating students separately revealed no significant correlation between individual students' written and practical scores (first students, ρ=0.06 and P=.42; second students, ρ=0.09 and P=.67).

No significant interaction was noted between the study site and the timing of the assessment (P=.61) (*Table* 3). Whereas practical scores for both the postworkshop and the retention assessments were significantly different between study sites (P<.001), changes in practical scores from the postworkshop to the retention assessments were not significant for any of the study sites (P≥.14).

Discussion

Although the mean assessment scores for the 1:4 TTR workshop group were higher than those for the 1:16 TTR groups in all postworkshop and retention assessments, these differences were not statistically significant. However, the timing of the assessment did have statistically significant effects on written and practical assessment scores. The postworkshop written assessment scores were significantly higher than preworkshop or retention scores. Furthermore, retention written assessment scores, although lower than

Table 2.
Student Scores on Written and Practical Assessments of Cervical Muscle Energy Techniques by Table Trainer–to-Student Ratio (TTR)[26]

	Written Assessment Score, Mean (SD)[a]			
Group	Preworkshop (n=92)	Postworkshop (n=92)	Retention (n=86)	*P* Value[b]
All Groups	4.0 (1.6)	7.3 (1.6)	6.4 (1.6)	<.001[c]
1:4 TTR	3.9 (1.5)	7.4 (1.5)	6.7 (1.2)	<.001[d]
1:8 TTR	4.3 (1.9)	7.6 (1.6)	6.3 (1.9)	<.001[c]
1:16 TTR	3.9 (1.3)	6.9 (1.6)	6.3 (1.6)	<.001[d]
***P* Value[e]**	.15	.21	.50	…

[a] Each written assessment included 10 multiple-choice, case-based items, for a maximum score of 10 points. Sample sizes shown (n) equal the number of student participants who completed the indicated assessment.
[b] *P* values were derived from Friedman tests for within-group comparisons of assessment scores by timing of the assessment.
[c] Preworkshop<retention<postworkshop.
[d] Preworkshop<postworkshop=retention.
[e] *P* values were derived from stratified Kruskal-Wallis tests (preworkshop) or stratified nonparametric analyses of covariance (postworkshop and retention) for between-group comparisons of TTR.

Table 3.
Student Scores on Written and Practical Assessments of Cervical Muscle Energy Techniques by COM Study Site

	Assessment Score, Mean (SD) [No. of Students][a]			
Study Site	Preworkshop	Postworkshop	Retention	*P* Value[b]
Written Assessment				
COM1	4.0 (1.4) [48]	7.2 (1.6) [48]	6.5 (1.7) [48]	<.001[c]
COM2	3.4 (1.7) [28]	7.1 (1.8) [28]	6.1 (1.5) [23]	<.001[c]
COM3	5.2 (1.3) [16]	7.9 (1.2) [16]	6.9 (1.6) [15]	<.001[c]
P Value[d]	<.001[e]	.62	.72	…
Practical Assessment				
COM1	NA	276.9 (31.0) [86]	266.5 (40.2) [88]	.14
COM2	NA	201.1 (54.7) [56]	199.0 (60.5) [45]	.82
COM3	NA	252.3 (45.8) [31]	235.8 (60.9) [31]	.16
P Value[f]	…	<.001[g]	<.001[g]	…

[a] Each written assessment included 10 multiple-choice, case-based items, for a maximum score of 10 points. Practical assessment scores were calculated for each technique performed, and each student performed 2 techniques; there was no significant interaction between study site and timing of the practical assessment (P=.61). Number of students indicates number who completed the indicated assessment at the indicated site.
[b] For written assessment scores, *P* values were derived from Friedman tests for within-group comparisons of scores by timing of the assessment. For practical assessment scores, *P* values were derived from general linear mixed models for within-site comparisons of scores by timing of the assessment.
[c] Preworkshop<retention<postworkshop.
[d] *P* values were derived from Kruskal-Wallis test (preworkshop) and nonparametric analyses of covariance (postworkshop and retention) for between-group comparisons of study sites.
[e] COM3<COM1=COM2.
[f] *P* values were derived from general linear mixed models for between-group comparisons of study sites.
[g] COM2<COM3<COM1.

Abbreviation: COM, college of osteopathic medicine.

Table 4.
Student Scores on Practical Assessments of Cervical Muscle Energy Techniques by Table Trainer–to-Student Ratio (TTR)

	Practical Assessment Score, Mean (SD)[a]		
Group	Postworkshop (n=92, n_T=173)[b]	Retention (n=86, n_T=164)[b]	*P* Value[c]
All Groups	248.0 (54.2)	242.2 (58.1)	…
1:4 TTR	266.3 (43.1)	248.1 (56.6)	.04
1:8 TTR	250.6 (47.5)	233.7 (66.4)	.02
1:16 TTR	230.3 (62.2)	244.7 (51.6)	.21
***P* Value**[d]	.06	.19	…

[a] Practical assessment scores were assigned for each technique performed, and each student performed 2 techniques. A significant interaction was found between TTR and the timing of the assessment (*P*=.02).
[b] n=number of student participants who completed the indicated assessment and n_T=number of graded techniques.
[c] *P* values derived from general linear mixed models for within-group comparisons of assessment scores by timing of the assessment.
[d] *P* values derived from general linear mixed models for between-group comparisons of scores by TTR.

postworkshop scores, were significantly higher than preworkshop scores. Postworkshop practical assessment scores were significantly higher than retention scores for both the 1:4 and 1:8 TTR groups but not for the 1:16 TTR groups.

Dubrowski and MacRae[12] also investigated student-to-instructor ratios by assessing medical students' suturing skills after a 1-hour workshop on wound closure. They randomly assigned medical students to 1 of 3 workshops, each with a different instructor-to-student ratio (1:2, 1:4, or 1:12). All groups underwent practical assessments before and immediately after the workshop, as well as a retention assessment 1 week later. (Dubrowski and MacRae used only practical assessments to assess suturing skills, rather than practical and written assessments, as in our current study.) They found that student scores for suturing skill performance were highest immediately after the workshop and declined significantly 1 week later, despite remaining higher than preworkshop scores. In addition, the students in groups with a 1:2 or 1:4 ratio learned suturing with a higher level of proficiency than those in the group with a 1:12 ratio, and this difference was evident at both postworkshop and retention assessments. Because they found no significant differences between the 1:2 and 1:4 ratio groups, Dubrowski and MacRae[12] concluded that 1:4 was probably the optimal instructor-to-student ratio. Additional studies with more participants that also evaluate other techniques and body regions are needed to determine with certainty whether TTR affects acquisition of OMT knowledge and skill.

During the workshops in the current study, first-year osteopathic medical students were exposed to multiple methods of presentation for learning muscle energy skills, including auditory, visual, written, and psychomotor methods. Although individual student learning styles vary, most students seem to prefer a multimodal delivery of educational content.[13] Therefore, the teaching methods used in our workshop presentation were designed to mimic those used to teach OMM at most COMs, but they may have affected immediate vs long-term retention scores. We permitted students to review a handout of the PowerPoint presentation they viewed during the workshop before they completed the postworkshop and retention written assessments. As a result, students who learn best through written materials may have scored better on the assessments than other students. Therefore, the current study may be assessing the effect of PowerPoint and video presentation instruction, augmented by various TTRs, instead of the effect of TTR alone on learning. In the suturing skills study by Dubrowski and MacRae,[12] the suturing skills were taught by live demonstration.

In the current study, students demonstrated techniques on each other, in pairs, during the practical assessments. During both practical assessments, criterion scores were significantly higher for the student who demonstrated the techniques second in a pair than the student who demonstrated first. This finding suggests that the second student may receive an advantage by observing the

Table 5.
Student Scores on Practical Assessments of Cervical Muscle Energy Techniques by Student Order in Paired Demonstrations

	Practical Assessment Score, Mean (SD)[a]					
	Postworkshop			Retention		
Score	1st Students (n_T=85)[b]	2nd Students (n_T=88)[b]	*P* Value[b]	1st Students (n_T=81)[b]	2nd Students (n_T=84)[b]	*P* Value[c]
Final	236.2 (62.0)	259.3 (42.7)	.003	240.1 (61.7)	244.2 (54.8)	.28
Criterion	25.7 (4.1)	27.1 (2.7)	.004	25.4 (4.1)	26.1 (3.8)	.03
Proficiency	9.1 (1.6)	8.5 (1.0)	.13	9.3 (1.6)	9.2 (1.4)	.99

[a] Practical assessment scores represent scores for individually graded cervical muscle energy techniques; each student performed 2 techniques, and all students performed in pairs.
[b] n_T=number of graded techniques.
[c] *P* values derived from general linear mixed models for between-group comparisons of assessment scores by student order.

technical elements of the techniques as demonstrated by the first student. In addition, we found no significant correlation between written and practical assessment scores even after accounting for student order, suggesting that OMT knowledge and skill acquisition are not related. Research[14] suggests that imagining a motor action, as is done during written assessments, and executing that function, as is done during practical assessments, are processed in different areas of the brain.

The current study had several limitations. Assessment scores were not included as part of a graded OMM curriculum; therefore, students may not have committed time and energy to learning the concepts taught during the workshop. Another limitation arises from the fact that all students were given a paper handout of the PowerPoint presentation used in the video portion of the workshop. The handout contained comprehensive content, including detailed written instructions and photographic illustrations for the cervical diagnosis and muscle energy techniques and illustrations of anatomic relationships. The written assessment items were primarily derived from the PowerPoint presentation, with the video providing additional demonstration of the techniques. No additional material was provided to the students by the table trainers. Because students had access to comprehensive handouts, these handouts may have confounded our assessment of the effect of TTR on knowledge and skill acquisition, as evidenced by the lack of correlation between written and practical assessment scores for individual students. Future studies may better isolate the effect of the TTR on student learning by eliminating the handout.

Another limitation was a disparity in the timing of the anatomy and OMM curricula at the different COMs, which affected scheduling of the workshops so that they occurred before that content was taught. Because spinal anatomy and palpatory skill development were taught at different times, this disparity is probably responsible for the significant differences in written and practical assessment scores between the COMs. For example, 1 COM offered an OMM practical assessment on thoracic and lumbar spinal diagnosis 2 weeks before the study workshops, and its students scored significantly higher on preworkshop written assessments than students at the other COMs. Another COM had no muscle energy technique training in their OMM curriculum before the study workshops, and its students scored significantly lower on the practical assessments. Recruitment issues also contributed to this limitation, because 1 of the COMs did not have a 1:16 TTR group; data from that COM therefore included assessment scores for only 1:4 and 1:8 TTR groups, which tended to be higher than those for 1:16 TTR groups. Future studies should ensure that all participants have the same basic training before the study workshops.

Conclusion

Although the mean assessment scores for the 1:4 TTR workshop groups were higher than those for the 1:16 TTR groups in all postworkshop and retention assessments, the differences were not statistically significant. Practical assessment scores for the 1:4 and 1:8 TTR workshop groups declined significantly between postworkshop and retention assessments. To better determine the effect of TTR on students' OMT knowledge and skill acquisition, future studies should include more participants for more statistical power, evaluate other techniques and body regions, and isolate the impact of detailed written handouts on assessment scores. The current study also found that student order in paired demonstrations may affect practical assessment scores because students who demonstrated techniques second scored higher than students who demonstrated techniques first. Therefore, COMs should consider randomizing student order during practical assessments.

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