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ORIGINAL RESEARCH

The Relation Between Theoretical and Practical Exams for Health Sciences Students at King Saud Bin Abdulaziz University for Health Sciences- Jeddah

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Introduction: A comprehensive approach to assessment is essential to ensure that all students' learning competencies are measured accurately. Therefore, multiple methods of assessment have been developed to address this matter. This Study aims to assess the correlation between health sciences students' performance on theoretical and practical exams.

Methods: A correlational study design was conducted. The academic performance of 352 students across theoretical/practical courses was tested. SPSS version 29.0 was used for analysis. Spearman's rho correlation (Rs), Wilcoxon, and Mann Whitney were computed at $p<0.05$.

Results: The theoretical performance was strongly correlated with the practical performance of all programs pooled together *(Rs* (352) = 0.67, $p<0.001$). Also, there was a strong correlation between theoretical and practical performance for male students *(Rs* (181) = 0.72, $p<0.001$), while a moderate correlation for female students *(Rs* (171) = 0.53, $p<0.001$). Mann–Whitney test revealed significant mean performance difference by gender both at theoretical (U = 9284, $p<0.0001$) and practical (U = 11,373, $p < 0.0001$) levels.

Conclusion: There were significant correlations between theoretical knowledge and practical skills across the selected four programs.; The mean student's performance was better in the practical skills than in the theoretical knowledge assessment, and female students surpassed male students in both practical and theoretical assessments in the four programs offered to both genders.

Keywords: correlation, health sciences student, King Saud bin Abdul-Aziz, performance, KSAU-HS

Introduction

Assessment refers to the organized process of concluding the progress and growth of students in their learning and development.[1] It defines, selects, designs, collects, analyzes, interprets, and uses the information to increase students' learning and development.[1] Since assessment promotes and drives students' learning, students tend to focus on the material that will be assessed.[2] Also, assessment can influence the amount and quality of the study and the allocation of student's efforts.[2] Therefore, assessment methods can significantly impact student learning in higher education, including medical education.[3]

Several criteria must be considered while selecting an assessment method, including reliability, validity, objectivity, and the assessment tool's ease of use or practicability.[4] Assessing knowledge is an essential part of tertiary and professional education. One of the most used methods is written assessment, which involves asking questions and requiring written responses.[5] Different formats, such as constructed and selected responses, can be used in written assessments. However, improving assessment strategies requires faculty development.[6] Practical/clinical performance needs a clinical environment to test real-life situations by applying learned theories into practice.[7]

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Furthermore, using assessment methods to evaluate students' theoretical knowledge is just as vital as using skills-based testing instruments to assess their practical skills. Multiple- Choice Questions (MCQs), Short Answer Questions (SAQs), Extended Matching Questions (EMQs), Objective Structured Clinical Examination (OSCE), and Objective Structured Practical Examination (OSPE) have all been developed to assess either theoretical knowledge or practical skills.[8,9] Each of these assessment tools has its own set of advantages and disadvantages.[8] Examinations in most fields of study might tend to be more theoretical and take the form of multiple-choice or essay questions. In selected few topics, where the course of study includes significant practical and theoretical components, students are tested on both components using different tests. The main modes of assessment used in the College of Applied Medical Sciences, Jeddah (CoAMS-J) include written tests such as structured essays, short answer questions, and multiple-choice questions (MCQs). Other assessment tools include student presentations, objective structured clinical examination (OSCE), objective structured practical examination (OSPE), and logbooks for practical performance. Table 1 illustrates the standardized assessment configuration employed at CoAMS across all academic programs. The final exams, encompassing both theoretical and practical components, are of equal weightage and contribute 30% each to the overall grade. This assessment methodology ensures a consistent evaluation process for all students, providing a fair and justifiable assessment of their knowledge and skills.

Performing well in cognitive tests does not necessarily mean good clinical performance.[10,11] Students with insufficient skill acquisition may remain deficient if they proceed in the program without providing opportunities to practice those skills.[8,12] This situation must be remedied by implementing a remediation system that allows clinical skill(s) to be practiced even after completing the internship. Introducing such innovation is a challenging task, and factual data on the average number and percentage of students failing in the skills component and the reasons students attribute to their failure are required to build a strong justification.

The field of applied medical sciences is a complex and multifaceted profession that requires knowledge of medicine and science, proficiency in art and dexterity skills, personal qualities, and social intelligence. While intellectual abilities and cognitive components are essential for a successful career, they should not solely predict academic performance and professional success. Applied medical sciences also require a high level of psychomotor skills. Understanding the relationship between theoretical and practical exams is essential for designing an appropriate curriculum and selecting appropriate educational and assessment methods. Several studies have found a significant correlation between theoretical knowledge and practical skills in various fields, such as dental, nursing, and medical education.[13–15] For example, a study on dental students suggested that their theoretical knowledge could predict their practical skills.[16] Similarly, a study of nursing graduates found that theory should underlie practice in nursing education.[17] Another study at St. George's University of London revealed a moderate correlation between MCQs and OSPEs in gross anatomy courses.[13] Finally, a study of pediatric nursing students found a moderate to strong correlation between academic and practical performance.[15]

To our knowledge, no study was conducted on the relationship between theoretical and practical exams for College of Applied Medical Sciences Students at King Saud bin Abdulaziz University for Health Sciences—Jeddah (KSAU-HS). This study aimed to find the relationship between theoretical and practical exams for KSAU-HS Students. The study-specific objective is to find the correlation between students' performance in cognitive and psychomotor domains among different programs and genders.

Table 1 Standardized Assessment Configuration at CoAMS-J, KSAU-HS Programs

Course requirement	Instrument	Weight/Equivalent Mark
Semester work	Assignments, case study, seminars and quizzes	(20%)
Midterm exam	Midterm written examination	(20%)
Final practical exams	(OPSE and/or OSCE)	(30%)
Final written exam	MCQ questions	(30%)
Total		**(100%)**

Methodology

Study Design, Setting, and Period

A retrospective, correlational study design was conducted. The study was conducted at King Saud bin Abdulaziz University for Health Sciences, Jeddah campus, which offers eight programs [ie Clinical Laboratory Sciences Program (CLSP), Clinical Nutritional Program (CLNP), Anesthesia Technology (ANTS), Emergency Medical Services (EMDS), Radiological Sciences (RADL), Occupational Therapy (OCCT), Respiratory Therapy (RESY), and Echo Cardiovascular Technology (ECAV)]. CoAMS programs' curriculum is designed to provide students with a comprehensive learning experience. While it incorporates traditional instructional methods, it also emphasizes modern teaching strategies to promote active and collaborative learning. Each program employs various techniques, such as problem-based learning (PBL) and small group discussions, to encourage students to engage more actively in their learning process. The field experience courses offered by each program are an integral part of the curriculum. These courses are introduced to students in their third and fourth years and aim to provide them with hands-on training, allowing them to apply the knowledge they have gained in real-life scenarios. Through these courses, students can gain practical experience and develop the skills needed to excel in their future careers. CoAMS programs offer a total of 162 courses, of which 67 are mixed courses (ie, courses that include both theoretical and practical parts), and those courses were the focus of the study. Health science students' scores in their courses and their comprehensive exams were obtained from the assessment Unit, CAMS-J, KSAU-HS, Jeddah. Data were collected from 19–29 October 2023.

Source and Study Population

The study included two batches of CAMS-J 3rd and 4th year male and female students (a total of 352). Health science students' scores in their courses and their comprehensive exams for two consecutive years from 2020 to 2022 were obtained.

Inclusion and Exclusion Criteria

Programs that are offered for both genders, [ie, Emergency Medical Services (EMDS, Radiological Sciences (RADL), Occupational Therapy (OCCT), and Respiratory Therapy (RESY)] were included. Courses that include both theoretical and practical parts were included.

All students with paired performance (theoretical and practical results) were included. Students who had only theoretical results, dropped, postponed, or withdrawn the semester were excluded.

Study Variables

Student performance (ie, theoretical and practical scores) in the mixed courses was the dependent variable (outcome variable), while gender and program were independent variables (explanatory variables).

Data Source and Measurement of Variables

Data were accessed with permission obtained from the Dean of COAMS-J. The obtained data were official grade points of the theoretical and practical performance of COAMS-J students on the mixed courses course kept at the assessment unit. The assessment configuration at CAMS is unified between all the programs in which the final written (mainly MCQs) exam comprises 30% of the total mark, and the same weight is allocated for the final practical exams (OPSE and/or OSCE).

Sample Size

The study included all third-year and fourth-year students enrolled in the following programs (EMDS, OCCT, RADL, RESY) that were offered for both sections (male and female) and have mixed courses (ie, courses that include both theoretical and practical parts). The total number of students was 352, and the total number of courses was 25. In order to determine if there was a correlation between two variables, a sample size of at least 47 is needed, with a minimum expected correlation coefficient of 0.4. This was calculated using the statistical software provided by the University of

California San Francisco with a 5% significance level and a power of 80%. You can find more information on this calculation at http://sample-size.net/correlation-sample-size/.

Sampling Technique

The study used a non-probability consecutive sampling method, where all students from the four programs (two batches) were included in the study. Consecutive sampling is similar to convenience sampling, but it aims to include all accessible subjects in the sample. Due to time, budget, and academic workload constraints, it can be difficult to sample the entire population randomly. Therefore, non-probability sampling techniques such as consecutive sampling were used as an alternative.

Results

The study analyzed the performance of 352 students who were enrolled in the core courses of four programs (EMDS, OCCT, RADL, RESY) at the College of Applied Medical Sciences- Jeddah in the academic years 2020–2021 and 2021–2022. The performance of these students was evaluated based on both theoretical and practical results, and data from two consecutive years, 2020 and 2021, was used for the analysis. According to the gender and academic level of the student participants, the current study showed that the total number of third-year students was 230 students; 50.4% of them were female, while 49.6% were male Table 2. Also, it was observed that the total number of fourth-year students was 122 students; 55% of them were female, while 67% were male Table 3. A summary of the total numbers of third-year and fourth-year students, categorized by program and gender, is provided in Table 4. Overall, the total number of females was (n = 171), and the total number of males was (n = 181), with a total percentage of 48.6% and 51.4%, respectively.

Regarding students' performance, the data indicates that female students have demonstrated superior academic performance compared to male students, across different academic programs and levels. Table 5 summarizes students' theoretical and practical scores' means and standard deviations across different academic programs, levels, and genders. In addition, this study showed that the student's mean performance across all programs was better in the practical skills assessment than in the theoretical knowledge assessment. This was statistically analyzed using the Wilcoxon test and is shown in (Figure 1).

Upon analyzing the assessment data, significant positive correlations between theoretical knowledge and practical skills were identified. The Spearman's Rho Correlation Coefficient (Rs) between the two assessments (ie, MCQs examination and End-of-block OSPE and/or OSCE) was strong for each of the four programs included in this analysis, and all four programs pooled together in Table 6. The overall Spearman's Rho Correlation Coefficient among all programs pooled together was 0.671 and $P < 0.001$ (Figure 2). The same outcomes were true for the correlations of

Table 2 Number of Third-Year Students and Their Academic Programs

Program	Female (%)	Male (%)	Total (%)
EMDS	27 (47.4%)	30 (52.6%)	57 (24.8%)
OCCT	27 (58.7%)	19 (41.3%)	46 (20.0%)
RADL	22 (52.4%)	20 (47.6%)	42 (18.3%)
RESY	40 (47.1%)	45 (52.9%)	85 (36.9%)
Total	**116 (50.4%)**	**114 (49.6%)**	**230 (100%)**

Table 3 Number of Fourth-Year Students and Their Academic Programs

Program	Female (%)	Male (%)	Total (%)
EMDS	26 (37.1%)	44 (62.9%)	70 (57.4%)
OCCT	29 (55.8%)	23 (44.2%)	52 (42.6%)
Total	**55 (45.1%)**	**67 (54.9%)**	**122 (100%)**

Table 4 Total Number of Third & Fourth-Year Students and Their Academic Programs

Program	Academic Year	Female (%)	Male (%)	Total (%)
EMDS	Third year	27 (47.4%)	30 (52.6%)	57 (24.8%)
OCCT	Third year	27 (58.7%)	19 (41.3%)	46 (20.0%)
RADL	Third year	22 (52.4%)	20 (47.6%)	42 (18.3%)
RESY	Third year	40 (47.1%)	45 (52.9%)	85 (36.9%)
EMDS	Fourth year	26 (37.1%)	44 (62.9%)	70 (57.4%)
OCCT	Fourth year	29 (55.8%)	23 (44.2%)	52 (42.6%)
Total		**171 (48.6%)**	**181 (51.4%)**	**352 (100%)**

Table 5 Third- and Fourth-Year Students' Mean Performance of Theoretical and Practical Exams Across Academic Programs

Program	Course	Gender		Mean Performance (standard Deviation)	
		(N) Frequency (%)		Theory	Practice
OCCT	311	Male Female	19(41.3%) 27(58.7%)	25.82 (2.95) 27.90 (1.49)	28.13 (2.77) 29.14 (0.99)
	315			21.91 (3.32) 24.60 (2.53)	27.02 (1.85) 27.21 (2.08)
	316			26.26 (2.03) 27.92 (0.97)	27.46 (3.33) 28.64 (1.63)
	318			23.34 (4.21) 25.74 (2.96)	26.10 (2.46) 26.35 (1.79)
	319			26.02 (2.22) 28.04 (1.23)	27.96 (1.42) 28.34 (1.57)
	411	Male Female	23(44.2%) 29(55.8%)	25.25 (2.40) 27.78 (1.48)	25.02 (2.38) 26.73 (2.58)
	413			25.30 (2.31) 26.48 (5.59)	27.91 (1.60) 28.57 (1.11)
	414			25.09 (2.54) 27.08 (2.03)	29.91 (0.42) 29.95 (0.27)
	417			26.19 (2.46) 27.44 (1.35)	25.47 (5.87) 27.85 (1.09)
	418			23.13 (4.58) 26.78 (1.99)	25.28 (4.88) 28.19 (2.97)
EMDS	311	Male Female	30(52.6%) 27(47.4%)	26.42 (2.37) 28.11 (1.19)	29.80 (0.31) 29.70 (0.59)
	312			26.42 (2.25) 27.68 (1.56)	29.52 (0.72) 29.50 (0.74)
	313			25.28 (2.31) 26.75 (2.03)	29.43 (0.97) 29.78 (0.46)
	314			25.81 (2.14) 27.01 (2.15)	28.73 (1.08) 29.93 (0.20)

(*Continued*)

Table 5 (Continued).

Program	Course	Gender		Mean Performance (standard Deviation)	
		(N) Frequency (%)		Theory	Practice
	315			27.03 (2.91) 27.74 (1.85)	29.04 (0.90) 29.17 (0.48)
	316			24.75 (3.57) 26.58 (2.50)	28.40 (1.50) 29.03 (1.19)
	411	Male Female	44(62.9%) 26(37.1%)	27.44 (2.46) 28.42 (1.90)	28.97 (1.47) 29.78 (0.34)
	413			26.23 (3.46) 27.84 (1.96)	29.10 (0.96) 29.44 (0.89)
	415			27.07 (2.40) 28.37 (1.23)	28.45 (1.46) 29.90 (0.39)
	417			26.90 (2.77) 28.87 (1.19)	29.03 (1.39) 29.90 (0.23)
RADL	312	Male Female	20(47.6%) 22(52.4%)	26.68 (2.12) 27.26 (2.80)	28.23 (1.57) 29.15 (1.41)
	313			26.80 (2.25) 28.72 (1.51)	28.70 (1.54) 29.34 (0.88)
	317			26.99 (2.69) 28.26 (1.59)	29.33 (1.49) 29.30 (1.03)
RESY	311	Male Female	45(52.9%) 40(47.1%)	25.87 (2.51) 27.56 (1.37)	25.92 (3.18) 27.41 (2.97)
	317			24.20 (3.36) 26.28 (2.44)	25.86 (3.84) 27.32 (3.07)

the theoretical-to-practical knowledge stratified by third- and fourth-year courses, showing a strong, significant positive correlation Table 7. The correlations of the theoretical-to-practical knowledge stratified by third and fourth-year courses and gender for four academic programs at CoAMS-J are illustrated in (Figure 3). Moreover, the correlations of the theoretical-to-practical knowledge stratified by gender in which all correlations were significant for each of the four programs included in this analysis as well as for all five programs pooled together. The *Rs* for females across programs varied from moderate to strong. On the other hand, *Rs* for males across programs varied from strong to very strong Table 8. This study found that students performed better in practical skills than theoretical knowledge across four programs, as analyzed through the Mann–Whitney test. Moreover, the mean performance of female students was better than that of male students in both theoretical knowledge and practical skills, which was identified using nonpaired test statistical analysis (ie, Mann–Whitney) in GraphPadPrism 10.1.0. (Figure 4).

Discussion

To the authors' knowledge, this was the first study that examined the relation between theoretical and practical exams for health sciences students at King Saud bin Abdulaziz University for Health Sciences- Jeddah. Among all programs, male students were 2% higher than female students Table 4. The study revealed a moderate to strong positive correlation between the theoretical and practical performance of CoAMS students in the core courses of the following programs: EMDS, OCCT, RADL, and RESY. The overall correlation coefficient was 0.671. The finding of

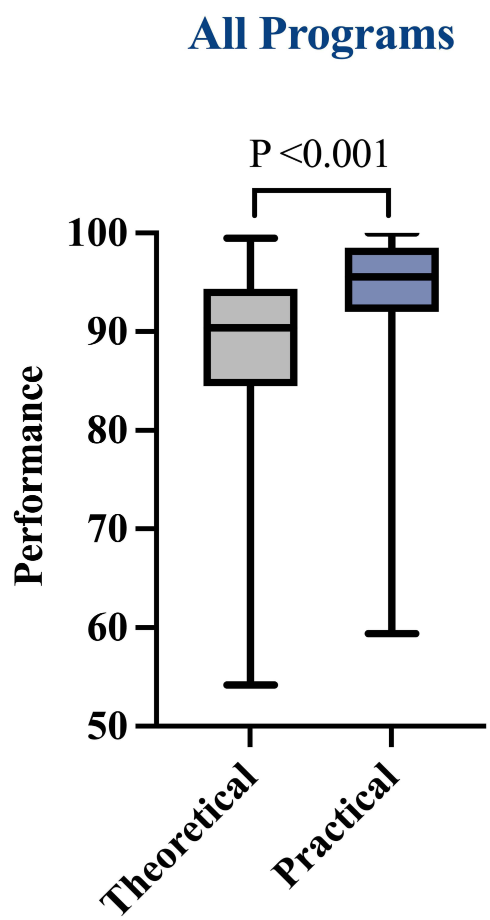

Figure 1 Comparison of students' means' performance between theoretical knowledge and practical skill.

this study was consistent with a study conducted by the College of Applied Medical Sciences students at King Saud bin Abdulaziz University for Health Sciences- Riyadh campus, with an overall correlation coefficient of 0.640.[18] This might indicate a positive correlation between academic (ie, theoretical and practical exams) and could be translated into better clinical performance, indicating that students who perform well in academic pursuits are likely to perform well in clinical practice. To improve the academic performance of students who struggle, it is recommended that additional support such as tutorials be provided, and active learning techniques such as simulation, case studies, and role-play should be incorporated. Such measures could ultimately enhance the clinical performance of health sciences students.

Table 6 The Correlation Between Theoretical (MCQs) and Practical Examination (OSPE/OSCE)

Program	Number of students (N)	Spearman's Rho Correlation Coefficient (R_s)	P (two-tailed)	95% confidence interval	
EMDS	127	0.761	<0.001	0.677	0.826
OCCT	98	0.767	<0.001	0.670	0.838
RADL	42	0.634	<0.001	0.409	0.787
RESY	85	0.713	<0.001	0.590	0.804
Overall	**352**	**0.671**	**<0.001**	**0.609**	**0.725**

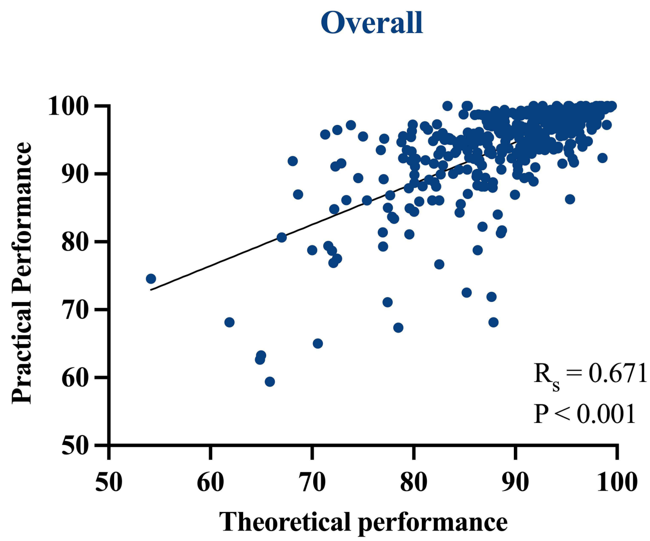

Figure 2 The correlation between theoretical and practical courses for four CoAMS-J programs.

Other studies have found a similar relationship when conducted with dental, medical, and nursing students.[13–15] A study examined the relationship between dental students' theoretical knowledge and practical skills in endodontics and evaluated the predictive validity of theoretical knowledge assessments on practical skills. Results from 447 students showed that theoretical knowledge was significantly associated with practical skills. The study concluded that a rough estimation of students' practical skills could be achieved by objectively measuring their theoretical knowledge.[16] Another study used a five-year dataset of nursing graduates from a Philippine Nursing University (N=653) and found a significant relationship between theoretical and practical skills. The study concluded that in nursing education, theory should underlie practice.[17] Furthermore, a study conducted at St. George's University of London (SGUL) Medical School in the UK showed a significantly moderate correlation between MCQs and OSPE exams in gross anatomy courses.[13] A study at Mizan-Tepi University examined the correlation between the academic and practical performance of 396 pediatric nursing students. Results showed a moderate to strong correlation between academic and practice performance. The study found significant differences in mean performance by admission type and gender, with male students achieving higher scores.[15]

This might indicate that increasing academic performance increases students' clinical performance and that students with high GPAs might perform better in the clinical setup. It is worth noting that enhancing students' academic performance can positively impact their clinical practice performance. It can be inferred that a strong academic foundation will enable students to better understand and apply clinical concepts in practice. Therefore, it is essential to prioritize academic excellence in order to ensure that students are well-equipped to excel in their clinical roles. Adequate orientation and systematic guideline-based assessment can positively influence the clinical practice performance of students. It is imperative for students to be well-equipped with the necessary skills and knowledge required for the clinical environment. The careful assessment of their abilities through well-defined guidelines can help identify areas where improvement is needed. By doing so, students can

Table 7 The Correlations of the Theoretical-to-Practical Knowledge Stratified by Third- and Fourth-Year Courses for Four Programs at CoAMS-J

Program	Number of students (N)	R_s for third year (P)	R_s for fourth year (P)
EMDS	127	0.797 (<0.001)	0.812 (<0.001)
OCCT	98	0.753 (<0.001)	0.789 (0.001)
RADL	42	0.634 (<0.001)	N/A
RESY	85	0.713 (<0.001)	N/A
Overall	**352**	**0.641 (<0.001)**	**0.767 (<0.001)**

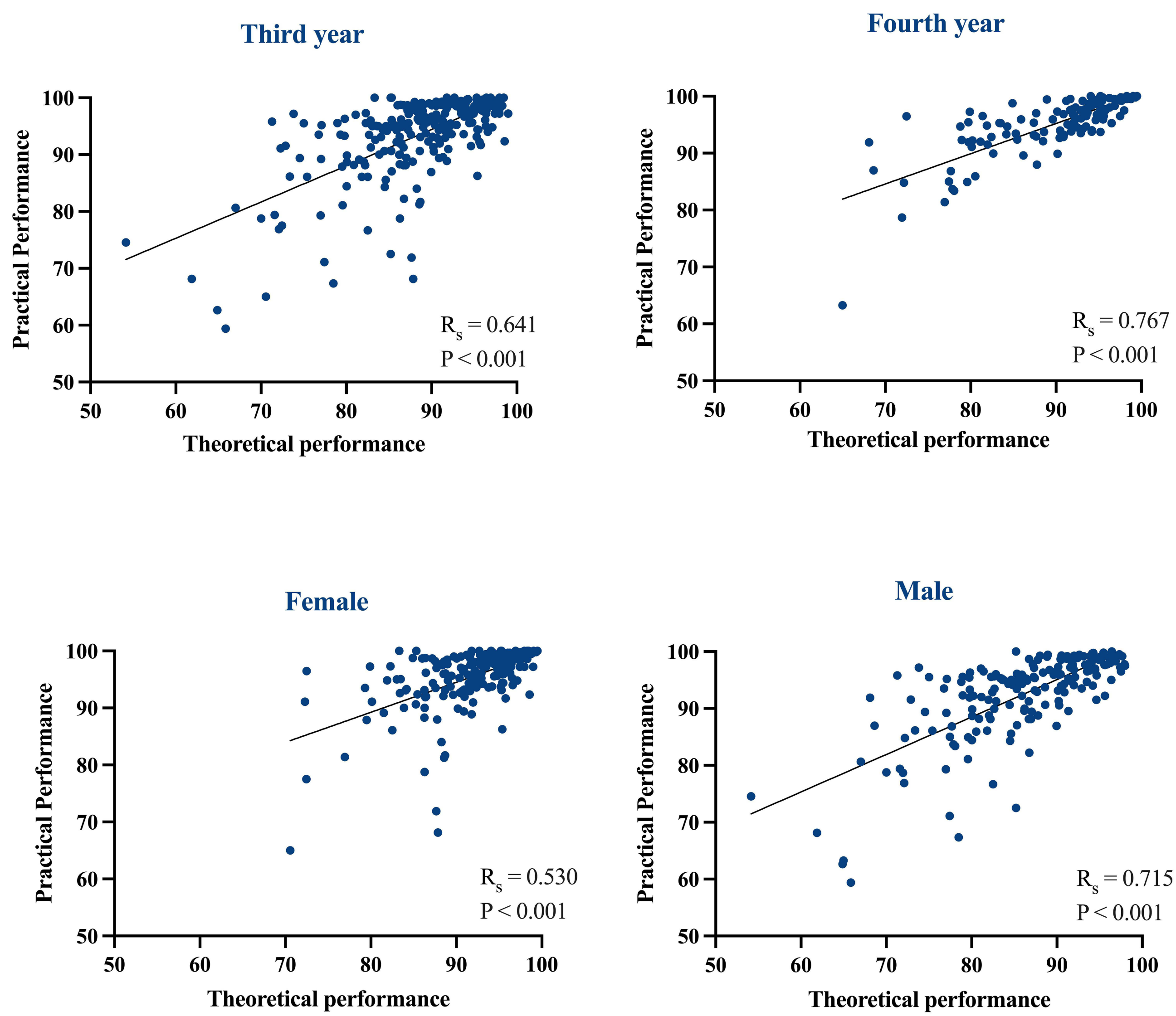

Figure 3 The correlations of the theoretical-to-practical knowledge stratified by third and fourth-year courses and gender.

enhance their clinical skills and provide quality care to patients. The Mann–Whitney results indicate significant mean performance differences between genders in both theoretical (MD = −5.2) and practical (MD = −2) contexts. These findings are in line with prior research.[19–22] It is noteworthy that gender appears to have a significant impact on performance, and this study adds to our understanding of the role of gender in academic and professional contexts.

Table 8 The Correlations of the Theoretical-to-Practical Knowledge Stratified by Gender for Four Academic Programs at CoAMS-J

Program	R_s Female (P)	R_s Male (P)	(N) Female	(N) Male
EMDS	0.797 (<0.001)	0.726 (<0.001)	53	74
OCCT	0.575 (<0.001)	0.820 (<0.001)	56	42
RADL	0.639 (0.001)	0.876 (<0.001)	22	20
RESY	0.531 (<0.001)	0.781 (<0.001)	40	45
Overall	**0.530 (<0.001)**	**0.715 (<0.001)**	**171**	**181**

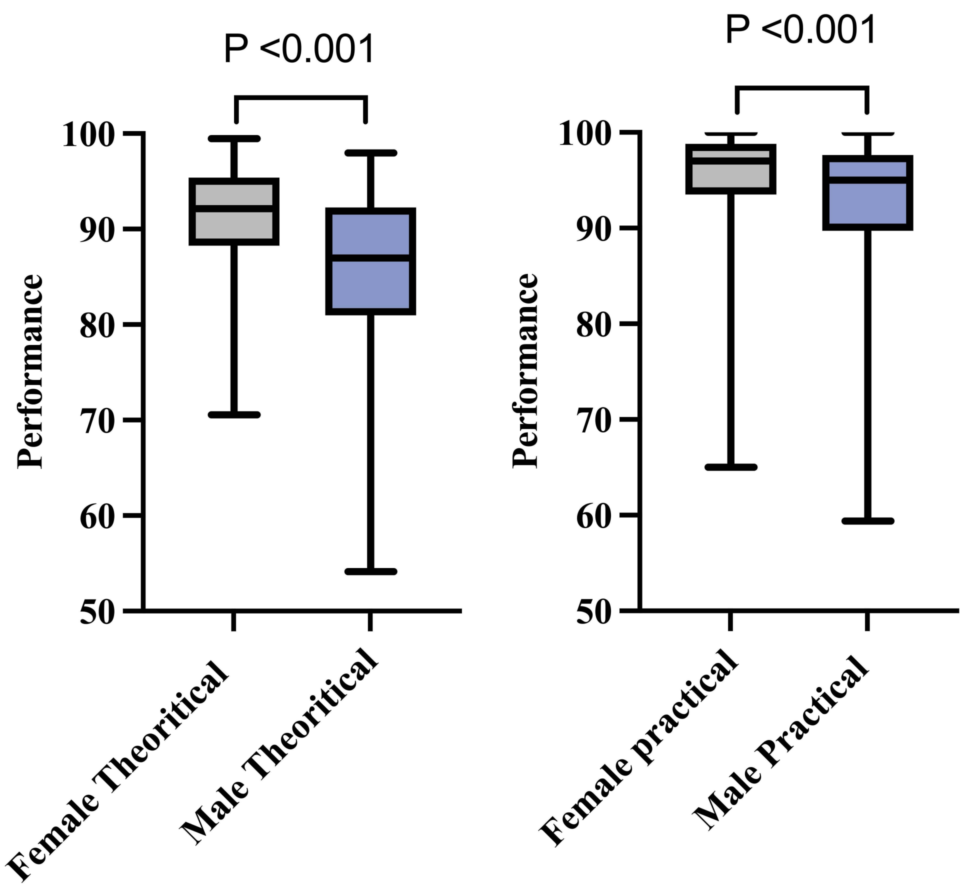

Figure 4 Comparison of students' means' performance in theoretical knowledge and practical skills between genders.

Limitations

In order to strengthen the analysis, it would be prudent to consider controlling for potential confounding variables such as pre-university academic performance, socio-demographic factors, and student age. Regrettably, these variables were not accounted for in the current analysis due to limitations in the available data. It would be beneficial to incorporate these variables in future research, as it would provide a more comprehensive understanding of the potential impact of these variables on the results.

Conclusion

Our study showed the relation between theoretical and practical exams for health sciences students at KSAU-HS, Jeddah. The study revealed significant correlations between theoretical knowledge and practical skills across the selected four programs. The study results indicated that students' mean performance was better in practical assessments than theoretical knowledge assessments, with female students surpassing male students in both practical and theoretical assessments in the four programs (ie, EMDS, OCCT, RADL, and RESY). As per the statistical data, female students have demonstrated significantly higher academic and practical accomplishments than their male counterparts. Hence, it is recommended that educators provide additional support to male students in both classroom and clinical settings to help them improve their performance and achieve excellence. According to the results of our study, it would be advisable to implement tutorial programs for students who exhibit low academic performance. Employing various active learning techniques, such as simulations, case studies, and role-playing, could potentially enhance their academic outcomes and, consequently, their performance in clinical practice.

Abbreviations

NCAAA, National Commission for Academic Assessment and Accreditation; MCQs, Multiple- Choice Questions; SAQs, Short Answer Questions; EMQs, Extended Matching Questions; OSCE, Objective Structured Clinical Examination and OSPE, Objective Structured Practical Examination; CoAMS-J, College of Applied Medical Sciences, Jeddah; CLSP, Clinical Laboratory Sciences Program; CLNP, Clinical Nutritional Program; ANTS, Anesthesia Technology; EMDS, Emergency Medical Services; RADL, Radiological Sciences; OCCT, Occupational Therapy; RESY, Respiratory Therapy; and ECAV, Echo Cardiovascular Technology; KSAU-HS, King Saud bin Abdulaziz University for Health Sciences; AU, Assessment Unit.

Ethics Statement

The written permission letter with"Ref No OUT- COAMSJ-RU/2023/035" was obtained from the dean of the College of Applied Medical Sciences, Jeddah (COAMSJ) for collecting COMAS-J student's performance data to conduct this research. This study was approved by the Institutional Review Board (IRB) committee of King Abdullah International Medical Research Center (KAIMRC) "SP23R/196/08.". The decision not to obtain consent was approved by the ethics review board. Furthermore, this study was conducted in accordance with the Helsinki Declaration. However, there was no consent to participate due to the nature of the data. Furthermore, no identifiable data was included and reported for this study.

Disclosure

The authors report no conflicts of interest in this work.

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