Orthopedic In-Training Examination: An Analysis of the Sports Medicine Section—An Update

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OBJECTIVE: Previously published studies have evaluated Orthopedic In-Training Examination sports medicine questions, but none have evaluated whether question difficulty has changed over time.

DESIGN: Sports medicine subsection questions between 2012 and 2016 were evaluated and compared with previously published data on Orthopedic In-Training Examination from 2004 to 2009. Question categories were classified into 1 of 3 taxonomy levels—basic recall, diagnosis, and advanced problem solving.

SETTING: Medical University of South Carolina; Charleston, SC, 29425; Institution.

PARTICIPANTS: Two residents evaluated the Sports Subsection questions separately. Then an attending physician evaluated the questions to resolve discrepancies. A statistician was used for analysis.

RESULTS: Utilization of imaging modalities averaged 37%, with 28% (11/39) of the questions containing 2 or more imaging modalities. There were increases in utilization of advanced problem-solving questions (45% vs. 27%, $p = 0.002$) and decreases in basic recall questions (49% vs. 67%, $p = 0.008$) compared with previously published data.

CONCLUSIONS: While the percentage of the Orthopedic In-Training Examination represented by sports medicine has remained relatively unchanged, there were fewer questions requiring residents to demonstrate simple recall and diagnosis, and increased demand to perform advanced problem solving while utilizing multiple imaging modalities. (J Surg Ed 76:286–293. © 2018 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: Question taxonomy, Question analysis, Orthopedic In-Training Exam

COMPETENCIES: Medical Knowledge, Practice-Based Learning and Improvement, Systems-Based Practice

ABBREVIATIONS: AAOS = American Academy of Orthopedic Surgery; ABOS = American Board of Orthopedic Surgery; OITE = Orthopedic In-Training Examination

INTRODUCTION

Since 1963, residents in the field of orthopedic surgery have taken the Orthopedic In-Training Examination (OITE) created by the American Academy of Orthopedic Surgeons under Dr. Clinton Compere leadership. The purpose of this test was to create a metric by which the academy and training programs could evaluate the knowledge of residents against a national norm, determine some minimal national standards for trainees in training programs, and measure the quality of teaching in a program.[1] Buckwalter et al. validated OITE scores as a reliable metric for assessment of a resident's knowledge and performance relative to other residents in orthopedics.[2]

As a result of OITE study guides being published annually, several research articles have been published examining the content and references of each subsection.[3–16] In the sports medicine subsection of the OITE, 2 previous studies have been published examining the content and references. Srinvasan et al. examined OITEs from 2004 to 2008, reporting 7.9% of questions were in the sports domain each year, and concepts pertaining to the anterior cruciate ligament was the most commonly

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tested topic.[17] Osbahr et al. performed a similar study utilizing OITEs from 2005 to 2009, with the addition of assessing resident performance. They showed that the mean resident performance for sports medicine subsection was 67.1% (range 57.5%-75.7%) correct.[18]

There have been several articles published looking into resources useful in preparation for the OITE.[19-21] Marker et al. examined 2002 to 2006 OITEs.[19] They found *The Journal of Bone and Joint Surgery (American vol.)* was the most frequently referenced journal (20% of all journal citings) and *Orthopaedic Knowledge Update* was referenced 22% for all textbook references. Stone et al. (2013) did a similar study but examined the average time between journal publication to its reference in the OITE.[21] They found the average time was 8.1 years (median: 6 years, mode: 2 years).

Another article by Krueger et al. examined how much of the content of the OITEs was covered by 3 commonly used review resources—*Miller's Review of Orthopaedics*, 5th edition, American Academy of Orthopaedic Surgeons *Comprehensive Orthopedic Review*, and www.orthobullets.com (OB).[22] They found that OB (99.4%) had significantly more answers to OITE questions compared with *Miller's Review of Orthopaedics* (60%) and *Comprehensive Orthopedic Review* (62%; $p < 0.0001$). The ability to cover the information needed for the OITE provide easy access at any desktop and ability to be stay up to date on the current journal publications makes online resources like OB ideal for studying.

The purpose of the current study is to conduct a detailed analysis of the sports medicine subsection of the OITE over the last 5 years, and compare these results with the previously published data.

METHODS

The most recent 5 years (2012-2016) of the OITE were reviewed, including the questions, answers, and supporting references. The OITE Study Guide for Residents stratifies OITE questions into 10 subsections—*Basic Science and Orthopedic Diseases*, *Foot and Ankle*, *Hand*, *Hip and Knee Reconstruction*, *Oncology*, *Pediatrics*, *Shoulder and Elbow*, *Spine*, *Sports Medicine, and Trauma*. The "Sports Medicine" subsection of each year was evaluated for the total number and percentage of questions specific to sports medicine. Questions were further cataloged by topic category, taxonomy level, and location. An anatomical location was noted for each question (i.e., shoulder, knee, other). After questions were categorized according to anatomical location, they were further evaluated for question content. Any type of imaging modalities (clinical photographs, videos, and/or imaging study) used by a question was recorded.

The question taxonomy was determined utilizing the model defined by Frassica et al.[7] and Buckwalter et al.[2] Each question was classified into 1 of 6 categories as follows: (1) orthopedic knowledge, (2) knowledge of treatment modalities, (3) diagnosis, (4) diagnosis with recognition of associated conditions, (5) diagnosis with further studies, and (6) diagnosis with treatment. There are 3 taxonomy levels that the question categories fell within. Taxonomy level 1 is the most basic and requires simple knowledge recall; categories 1 and 2 fall within this taxonomy. Taxonomy level 2 queried the examinee to establish a diagnosis; all category 3 questions fall within this taxonomy. Taxonomy level 3 required the examinee to demonstrate advanced complex problem-solving abilities; all category 4, 5, and 6 questions fall within this taxonomy.

IBM SPSS (Version 24.0, Armonk, New York, 2007) statistical analysis was used to compare question category, taxonomy, and percentage of questions with images from year 2012 to 2016 and correlations across the year from 2012 to 2016. A 2-sample z test for proportions was used to compare averages for question frequency, presence of clinical photo and/or imaging study, category, and taxonomy level to previously published data. Spearman Rho correlation was used to assess the relationship among question musculoskeletal anatomic location and the study years. Alpha was set at $p \leq 0.05$; beta was set at 0.8.

Each question's content was searched within a commonly used online reference, www.orthobullets.com, in order to determine what percentage of the sports medicine content was covered. Reference sources cited as supporting evidence for the question were recorded. Book references and journal references were evaluated separately.

RESULTS

In the most recent 5 years of OITE, the sports medicine subsection data represented 7.7% (range, 6.7%-8.4%) of the questions (106/1375, average 21.2 questions per year; range 19-23; Table 1). In total, 38 different sports medicine topics were covered that were further

TABLE 1. Sports Medicine Questions on the Orthopedic In-Training Examination (OITE)

Year	No. Questions	% Total Questions (n = 1375)
2012	21	7.6
2013	21	7.6
2014	19	6.9
2015	22	8.0
2016	23	8.4
Total	106	7.7

classified into 7 broader categories. Knee (37/106), shoulder (19/106), and other (17/106) are the 3 most commonly tested topics (Table 2). Musculoskeletal anatomic location across the year correlations showed strong correlation values and statistically significant differences at several time points as noted in Table 7. Category 1 (orthopedic knowledge) was the most common category (Table 3), which corresponds with the most commonly test taxonomy, taxonomy level 1 (basic recall; Table 4).

Review of the data demonstrates that the sports medicine subsection utilized 4 different types of imaging—radiographs, magnetic resonance imaging, video, and clinical photographs. Thirty-seven percent (37%, 39/106) of the question stems utilized imaging, with 28% (11/39) of those questions utilizing 2 or more imaging modalities ($p = 0.31$; Table 4). Radiographs were the most commonly used imaging modality (22/46, 48%; Fig.). Throughout the course of the 5 years, the use of imaging was relatively inconsistent, ranging from 4 in 2013 up to 13 in 2014.

TABLE 2. Most Commonly Tested Sports Medicine Topics on the Orthopedic In-Training Examination (OITE)

	2012	2013	2014	2015	2016	Total
Shoulder						
Shoulder dislocation	1					1
Shoulder instability	2	1		1	2	6
Spinoglenoid cysts	1	1				2
Rotator cuff	1	2	1	1		5
Biceps pathology		1				1
Throwing injuries	1				1	2
Winged scapula				1	1	2
Elbow						
Ulnar collateral ligament injury		1		1		2
Throwing injury			1	1		2
Radioulnar synostosis			1			1
Lateral epicondylitis					1	1
Medial epicondylitis					1	1
Elbow stenosis				1		1
Knee						
ACL	3	2	3	6	3	17
Multiligament repairs				1		1
Patellar dislocation	1			1	1	3
Patellar tendonitis					1	1
Patellar tendon rupture					1	1
Patellofemoral syndrome	2					2
Meniscus pathology		2	2			4
Osgood-Schlatter			1			1
Posterior oblique ligament	1					1
Hamstring pathology			1	1		2
Stress fractures		2	1	1		4
Other						
Basic science/anatomy	2		1	1	1	5
Overuse injuries young athletes		1				1
General medical conditions impacting play		1				1
Heat injury		1				1
Concussion				1	1	2
Asthma				1		1
Return to play protocols				1		1
Patient safety		1	2		2	5
Infection						
Infection	1					1
Deformity						
OCD		1				1
Calcaneonavicular coalition			1		1	2
Elbow osteophyte resection						0
Neurologic						
Axillary nerve injury	1	1				2
Disc herniation				1		1

OCD = osteochondral defect; ACL = anterior cruciate ligament.

TABLE 3. Question Taxonomy Category for the Sports Medicine Questions on the Orthopedic In-Training Examination (OITE)

Category	2012	2013	2014	2015	2016	Total (%)
1	9	6	4	8	11	38 (35.8)
2	2	5	1	4	2	14 (13.2)
3	1	0	2	0	3	6 (5.7)
4	3	2	3	1	1	10 (9.4)
5	0	1	0	0	2	3 (2.8)
6	6	7	9	9	4	35 (33.0)

Categories: 1, knowledge; 2, knowledge of treat modalities; 3, diagnosis; 4, diagnosis with recognition of associated conditions; 5, diagnosis with further studies; 6, diagnosis with appropriate treatment.

The 5 years of sports medicine OITE questions referenced journal articles in 97% (103/106) of questions, for a total of 217 references. *The American Journal of Sports Medicine* was the most commonly cited journal (23%), followed by *The Journal of Bone and Joint Surgery (American edition)* (14%), and *The Journal of the American Academy of Orthopaedic Surgeons* (12%; Table 5). Textbooks were cited less frequently than journal articles, with 12 textbooks cited a total of 18 times. *Orthopaedic Knowledge Update*: *Sports Medicine* 4 (17%) and *Instructional Course Lectures* (17%) were the 2 most commonly cited textbooks, follow by *Foot and Ankle* (11%) and O*rthopaedic Knowledge Update* 10 (11%; Table 6). Searching www.orthobullets.com for the question topic demonstrated that 100 of the 106 questions (94.4%) were answered within its content.

Data from 2012 to 2016 were compared with previously published data from 2004 to 2008 by Srinivasan et al.[17] Compared with previously published data, the percentage of sports medicine questions on the OITE remained constant (7.7% vs. 7.9%, p = 0.85; Table 1). The last 5 years taxonomy demonstrated a significant increase in advanced problem solving (45% vs. 25%, p = 0.002) with a decrease in the number of simple recall questions (49% vs. 67%, p = 0.008; Table 4). There has also been increased utilization of imaging modalities for the current OITE (37% vs. 20%, p = 0.006).

Data from 2012 to 2016 were compared with previously published data from 2005 to 2009 by Osbahr et al.[18] Compared with previously published data, the percentage of sports medicine questions on the OITE remained constant (7.7% vs. 7.8%, p = 0.92; Table 1). The last 5 years taxonomy demonstrated a significant increase in advanced problem solving (45% vs. 20%, p = 0.0001) with a decrease in the number of diagnostic questions (6% vs. 22%, p = 0.001; Table 4). There was a noted increase in the total number

TABLE 4. (a and b) Sports Medicine Question Taxonomy and Imaging on the Orthopedic In-Training Examination (OITE) Direct Comparison with 2 Previously Published Papers by Srinivasan et al. and Osbahr et al.

Parameters	2012-2016 No. Questions (%)	2005-2009* No. Questions (%)	2-sample z-Test for Proportions, p
Taxonomy Level			
1	52 (49)	62 (58)	.18
2	6 (6)	23 (22)	.001
3	48 (45)	21 (20)	.0001
Questions with photos or images	39 (37)	29 (27)	.12
Total number of questions	106	106	

Parameters	2012-2016 No. Questions (%)	2004-2008† No. Questions (%)	2-sample z-Test for Proportions, p
Taxonomy Level			
1	52 (49)	71 (67)	.008
2	6 (6)	8 (8)	.57
3	48 (45)	27 (25)	.002
Questions with photos or images	39 (37)	21 (20)	.006
Total number of questions	106	106	

*Osbahr et al.
†Srinivasan et al.

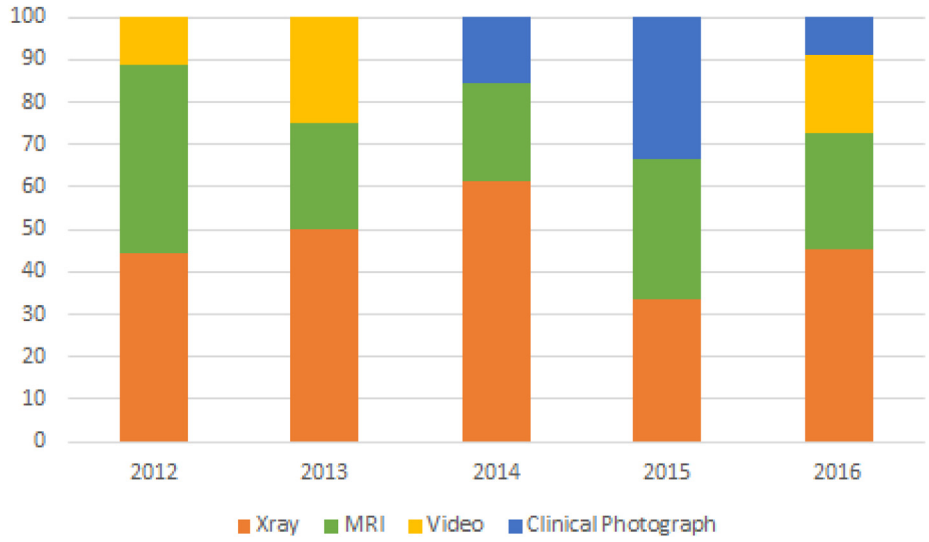

FIGURE. Percentage distribution of clinical photographs and imaging modalities tested from 2012 to 2016.

of imaging modalities used, but it was not statistically significant (37% vs. 27%, p = 0.12).

DISCUSSION

Since the inaugural 150 question paper examination, the OITE has expanded to 275 questions subdivided into 10 subsections—*Basic Science and Orthopedic Diseases*, *Foot and Ankle*, *Hand*, Hip and Knee Reconstruction, *Oncology*, *Pediatrics*, *Shoulder and Elbow*, *Spine*, *Sports Medicine*, and *Trauma*. Trainees are provided with scoring reports showing how they scored nationally among their peers in each of the subsections of the exam. It has been shown that how well applicants perform on the OITE has been correlated to performance on American Board of Orthopedic Surgery Part I.[23,24] The OITE becomes a valuable asset to trainees to identify areas for improvement as they prepare for the ultimate goal of passing their orthopaedic board examination.[25]

The most recently published data on the sports medicine portion of the OITE reflect data that is 6 years old,[18]

TABLE 5. Recommended Readings: Most Commonly Referenced Journals

Journal References	Total Number of References
The American Journal of Sports Medicine	50
The Journal of Bone and Joint Surgery—American volume	30
The Journal of the American Academy of Orthopaedic Surgeons	27
Arthroscopy	20
Journal of Shoulder and Elbow Surgery	10
Knee Surgery, Sports Traumatology, Arthroscopy	8
Clinics in Sports Medicine	7
Medicine & Science in Sports & Exercise	5
Clinical Orthopaedics and Related Research	5
Journal of Pediatric Orthopaedics	5
Skeletal Radiology	4
The Journal of Bone and Joint Surgery—British volume	4
Clinical Journal of Sports Medicine	4
British Journal of Sports Medicine	3
Sports Health	3
Physical Medicine and Rehabilitation Clinics of North America	2
New England Journal of Medicine	2
Sports Medicine	2
Journal of Athletic Training	2
Current Reviews in Musculoskeletal Medicine	2
Sports Medicine and Arthroscopy Review	2

20 additional journals were referenced 1 time each.

TABLE 6. Recommended Readings: Most Commonly Referenced Textbooks

Book References	2012	2013	2014	2015	2016	Total
Orthopaedic Knowledge Update: Sports Medicine 4	0	3	0	0	0	3
Instructor Course Lecture	0	1	2	0	0	3
Foot and Ankle	1	1	0	0	0	2
Orthopaedic Knowledge Update 10	0	1	0	1	0	2
NCAA Sports Medicine Handbook	0	1	0	0	0	1
Orthopaedic Knowledge Update 8	0	1	0	0	0	1
AAOS Monograph Vol 39	0	0	1	0	0	1
US Dept of Health Research Website	0	0	1	0	0	1
Cockpit Resource Management	0	0	1	0	0	1
Orthopaedic Knowledge Update 11	0	0	0	1	0	1
Orthopaedic Knowledge Update: Sports Medicine 3	0	0	0	0	1	1
WHO Surgical Safety Checklist and Implementation Manual	0	0	0	0	1	1

NCAA = National Collegiate Athletic Association; AAOS = American Association of Orthopaedic Surgeons; WHO = World Health Organization.

and the only other published paper evaluating the section reflects data that is 8 years old.[17] This study serves to update orthopedic trainees, orthopedic residency programs, and the American Academy of Orthopedic Surgery (AAOS) Evaluation Committee with the most current data reflecting the content of the examination.

Knee (35%), shoulder (18%), and other (16%) are the 3 most commonly tested topics over the last 5 years (Table 2). From 2005 to 2009, the 3 most commonly tested topics were knee (42.5%), shoulder (16%), and medical-related questions (13.2%).[18] The 2004 to 2008 data were analyzed differently, with the most commonly tested topic being the anterior cruciate ligament (23.5%).[17] Knee-related sports injuries have consistently been 1 of the most commonly tested topics on the OITE sports medicine section. The correlations between the years were varied with several years showing strong r values and statistically significant differences (Table 7).

The number of questions requiring residents to demonstrate advanced problem skills significantly increased (taxonomy 3; 45% vs. 25%, $p = 0.002$; Table 4).[17] Additionally, the frequency and types of imaging modalities utilized in the question stems have also changed. The 2004 to 2009 imaging modalities included radiographs, radiographic arthrogram, computed tomography scanning, magnetic resonance imaging, bone scintigraphy, clinical photographs, intraoperative photographs, and arthroscopic photographs.[17,18] With the implementation of electronic in-training examination in 2009, videos and complex multislice imaging began being incorporated into questions for trainees.[26] The most recent examinations have implemented the use of videos; representing 8% of all imaging utilized over the last 5 years, while bone scintigraphy and computed tomography scanning were not used.

Despite the frequency of the questions remaining the same, the sports medicine portion of the OITE has become more difficult. Questions are no longer simple recall questions (49% vs. 67%, $p = 0.008$). Tests are favoring increasingly challenging questions requiring advanced problem solving (45% vs. 25%, $p = 0.002$) and ability to read and interpret imaging and clinical photos (37% vs. 20%, $p = 0.006$). This trend does not appear to be unique to sports medicine. A recent study updating the pediatric portion of the OITE also noted increased difficulty of the section, with a statistically significant increase in the use of imaging modalities and increased question complexity.[11]

Several limitations exist. This study only evaluated questions that had been predesignated by the AAOS as sports medicine. Sports medicine often overlaps into other subspecialties, so by using the AAOS guide some questions may have been categorized into a differing subspecialty thus potentially affecting the question content, taxonomy,

TABLE 7. Musculoskeletal Anatomic Location Across the Year Correlation

Years	2012	2013	2014	2015	2016
2012				r = 0.70 (p = 0.005)	r = 0.66 (p = 0.01)
2013			r = 0.65 (p = 0.01)	r = 0.58 (p = 0.03)	
2014					r = 0.76 (p = 0.002)
2015			r = 0.73 (p = 0.003)	r = 0.86 (p = 0.001)	
2016		r = 0.60 (p = 0.02)			

and overall percentage representation. We performed only limited inter-rater reliability when assessing the question categorization, with 3 physicians evaluating the questions. Last, while we utilized the Bloom taxonomy, other studies have followed the Buckwalter taxonomy.

In conclusion, while the percentage of the OITE represented by sports medicine has remained relatively unchanged, the difficulty of the section has increased. There are fewer questions requiring residents to demonstrate simple recall and diagnosis, and instead demand that residents perform advanced problem solving. This is further complicated by the increasing utilization of multiple imaging modalities, with 28% (11/39) of the questions utilizing 2 or more imaging modalities. In order to adequately prepare residents for the American Board of Orthopedic Surgery examination, residency programs must ensure that they are well versed in imaging interpretation and stay abreast of changes to the traditionally emphasized sports medicine topics. This study can be utilized to guide resident education didactic curricula as it represents the most current trends within the sports medicine portion of the OITE.

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SUPPLEMENTARY INFORMATION

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