

Academic Characteristics of Orthopedic Team Physicians Affiliated With High School, Collegiate, and Professional Teams

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Abstract

We conducted a study to determine the academic involvement and research productivity of orthopedic team physicians at high school, college, and professional levels of sport.

Through Internet and telephone queries, we identified 1054 team physicians from 362 institutions, including 120 randomly selected high schools and colleges and 122 professional teams (baseball, basketball, football, hockey). For all physicians included in the study, we performed a comprehensive search of the Internet and of a citation database to determine academic affiliations, number of publications, and h-index values.

Of the 1054 physicians, 678 (64%) were orthopedic surgeons. Percentage of orthopedic team physicians affiliated with an academic medical center was highest in professional sports (64%; 173/270) followed by collegiate sports (36%; 98/275) and high school sports (20%; 27/133). Median number of publications per orthopedic team physician was significantly higher in professional sports (30.6) than in collegiate sports (10.7) or high school sports (6). Median number of publications by orthopedic physicians also varied by sport, with the highest number in Major League Baseball (37.9; range, 0-225) followed by the National Basketball Association (32.0; range, 0-227) and the National Football League (30.4; range, 0-460), with the lowest number within the National Hockey League (20.7; range, 0-144).

Academic affiliation and research productivity of orthopedic team physicians vary by competition level and professional sporting league.

is to care for the athlete, other responsibilities include administrative and legal duties, equipment- and environment-related duties, teaching, and communication with parents, coaches, and other physicians.²⁻⁴ These responsibilities differ greatly by the level of the athlete and the team being covered. For example, compared with high school and collegiate sport physicians, physicians caring for professional athletes may have increased interaction with the media.⁵

Despite the increasing demands and responsibilities of team physicians, it is important that they continue to advance the field of sports medicine through teaching and research.^{3,6} Team physicians have direct access to athletes at multiple levels of competition, from novice to professional, and therefore have a unique understanding of the injuries that commonly affect these athletes. Efforts to both teach and study the prevention, diagnosis, and treatment of these injuries have dramatically advanced the field of sports medicine. In fact, several advancements in sports medicine have come from team physicians, including advancements in anterior cruciate ligament reconstruction,^{7,8} shoulder arthroscopy,⁹ and “Tommy John” surgery,¹⁰ to name a few.

Given the important role of team physicians (particularly orthopedic team physicians) in advancing sports medicine, it is important to understand the degree to which team physicians at all levels of sport contribute to teaching and research.

We conducted a study to determine the overall academic involvement of orthopedic team physicians at all levels of sport, including the degree to which these physicians are affiliated with academic medical centers (by level of sport and by professional sport) and the quantity and impact of these physicians’ scientific publications. We hypothesized that orthopedic physician academic involvement would be higher at the professional level of sport than at the collegiate or high school level and that the degree of physician academic involvement would differ between professional sporting leagues.

Materials and Methods

In August 2012, we performed a comprehensive telephone- and Internet-based search to identify a sample of team physicians caring for athletes at the high school, collegiate, and profes-

The responsibilities of team physicians have increased dramatically since the early 19th century, when these physicians first appeared on the sidelines during football games.¹ Although the primary role of the team physician

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sional levels of sport. Data were collected on all team physicians, regardless of medical specialty. We defined a physician as any person listed as having either a doctor of medicine (MD) or a doctor of osteopathic medicine (DO) degree. A physician listed as a team physician at 2 different levels of competition (high school, college, professional) was included in both cohorts. A physician listed as a team physician in 2 different professional sports leagues was included independently for both leagues. All other medical personnel, including athletic trainers, therapists, and nursing staff, were excluded. Data on our sample population were collected as follows:

1. High school. Performing a comprehensive database search through the US Department of Education, we generated a list of all 20,989 US schools that include grades 9 to 12.¹¹ We then used a random number generator (random.org) to randomly select a sample of 120 high schools. These schools were contacted by telephone and asked to identify the team physician(s) for their sports teams. Twenty of these schools reported not having an athletic team, so we randomly generated a list of 20 additional high schools. High schools that had an athletic team but denied having a team physician were included in the analysis.

2. College. We used the National Collegiate Athletic Association (NCAA) website (ncaa.org) to generate a list of all colleges affiliated with the NCAA. Of these colleges, 347 were Division I, 316 were Division II, and 443 were Division III. The random.org random number generator was used to generate a list of 40 schools for each division, for a total of 120 schools. An Internet-based search was then performed to identify any and all team physicians caring for athletes at that particular school. In select cases, telephone calls were made to determine all the team physicians involved in the care of athletes at that institution.

3. Professional. Team physician data were collected for 4 of the most popular professional sporting leagues¹²: Major League Baseball (MLB), National Basketball Association (NBA), National Football League (NFL), and National Hockey League (NHL). Each team's official website was identified through its league website (mlb.com, nba.com, nfl.com, nhl.com), and the roster or directory listing of all team physicians was recorded. In 2 cases, the team's medical personnel listing could not be retrieved through the Internet, and a telephone call had to be made to identify all team physicians. Team physicians were identified for 122 professional teams: 30 MLB, 30 NBA, 32 NFL, and 30 NHL.

For this study, all physicians were classified as either orthopedic or nonorthopedic. Orthopedic surgeons—the focus of this study—were defined as those who completed residency training in orthopedic surgery. Median number of orthopedic and nonorthopedic surgeons per team was calculated at the high school, collegiate, and professional levels.

After identifying all orthopedic team physicians, we performed additional Internet searches to determine any affiliation between each physician and an applicable academic medical center. Physicians were placed in 1 of 3 different categories based on “level” of academic affiliation. Orthopedists with no

identifiable connection to an academic medical center were listed under *none*. The first 100 search results were studied before this determination was made. Orthopedists with any academic affiliation below the level of full professorship were placed in the category *associate/assistant/adjunct professor*, which included any physician who was an associate professor, adjunct professor, clinical instructor, or volunteer instructor at an academic medical center. Last, orthopedists listed as full professors were placed in the *professor* category.

Number of publications written by each orthopedic team physician was then calculated using SciVerse Scopus (scopus.com), a comprehensive abstract and citation database of research literature that offers complete coverage of the Medline and Embase databases.¹³ Scopus offers a Scopus Author Identifier, which assigns each author in Scopus a unique identification number.¹⁴ This number is based on an “algorithm that matches author names based on their affiliation, address, subject area, source title, dates of publication citations, and co-authors.”¹⁴ Authors whose names did not appear in Scopus were assumed to have no publications, and this was reported after cross-referencing with Medline to ensure no documents were missed. This study included all publications: original research articles, reviews, letters, and commentaries. Any level of authorship (first, second, etc) was included. All publications were scanned, and duplicate listings were not included. Median number of publications per orthopedic team physician was calculated at the high school, college, and professional levels.

We also determined the h-index for each orthopedic team physician. The h-index is used to measure the impact of the published work of a scholar: “A scientist has index h if h of his/her papers have at least h citations each, and the other papers have no more than h citations each.”¹⁵ For example, an h-index of 12 means that, out of an author's total number of publications, 12 have been cited at least 12 times, and all of his or her other publications have been cited fewer than 12 times. All authors in Scopus are automatically assigned h-indexes, and we collected these numbers.¹⁶ Of note, citations for articles published before 1996 are not included in the h-index calculation. Median h-index score per orthopedic team physician was calculated at the high school, college, and professional levels.

Analysis of variance was used to compare continuous data (eg, number of publications per surgeon) across different groups (eg, physicians from respective sports). Chi-square tests were used to detect whole-number differences between groups (eg, difference in number of physicians per team across the various professional sports leagues). Statistical significance was set at $P < .05$.

Results

We identified 1054 team physicians among the 362 total high schools, colleges, and professional sports teams included in this study. Of the 1054 physicians, 678 (64%) were orthopedic surgeons (Table 1). Seventy-two (60%) of the 120 high schools did not have a team physician, whereas all the colleges and professional teams did. Number of orthopedic surgeons per

team was higher at the collegiate level (2.29; range, 0-11) and professional level (2.21; range, 1-9) than at the high school level (1.11; range, 0-24) (Table 1). Median number of nonorthopedic surgeons was highest in professional sports (1.88; range, 0-9) followed by college sports (1.06; range, 0-9) and high school sports (0.16; range, 0-2) (Table 1).

Of the 678 orthopedic team physicians, 298 (44%) were officially affiliated with an academic medical center, either as clinical instructor, associate/adjunct professor, or full professor. Percentage of orthopedists affiliated with an academic medical center was highest in professional sports (173/270, 64%) followed by collegiate sports (98/275, 36%) and high school sports (27/133, 20%) ($P < .001$, Table 2). Percentage of orthopedists identified as full professors was highest at the professional level (42/270, 16%) followed by the collegiate level (14/275, 5.1%) and the high school level (3/133, 2.3%) ($P < .001$, Table 2).

We found 12,036 publications written by the 678 orthopedic team physicians included in this study. Median number of publications per orthopedist was significantly higher in professional sports (30.6; range, 0-460) than in collegiate sports (10.7; range, 0-581) and high school sports (6.0; range, 0-220) ($P < .001$). Number of authors with more than 25 publications was highest at the professional level (82) followed by the collegiate level (27) and the high school level (7) (Table 3). Median number of publications per orthopedist was also higher at the professional level (12) than at the collegiate level (2) and high school level (1). Median h-index was higher among orthopedists in professional sports (7.1; range, 0-50) than at colleges (2.7; range, 0-63) and high schools (1.8; range, 0-32) ($P < .001$). Median h-index was also significantly higher at the professional level (5) than at the collegiate level (1) and high school level (0).

At the professional level of sports, we identified 499 team physicians (270 orthopedic, 54%; 229 nonorthopedic, 46%). Median number of orthopedic team physicians varied by sport, with MLB (2.8; range, 1-8) and the NFL (2.4; range, 1-4) having relatively more of these physicians than the NHL (2.0; range, 1-6) and the NBA (1.7; range, 1-9) (Table 4). Percentage of orthopedic team physicians affiliated with academic medical centers was highest in MLB (58/83, 69.9%) followed by the NFL (47/76, 61.8%), the NHL (37/60, 61.7%), and the NBA (31/51, 60.8%) (Table 5). Median number of publications by orthopedists also varied by sport, with the highest number in MLB (37.9; range, 0-225) followed by the NBA (32.0; range, 0-227) and the NFL (30.4; range, 0-460), with the lowest number in the NHL (20.7; range, 0-144) (Table 6). Median number of publications was the same (17.5) in MLB and the NFL and lower in the NBA (11) and the NHL (7.5). Median h-index was highest in the NFL (8.2; range, 0-50) and MLB (7.9; range, 0-32) followed by the NBA (6.6; range, 0-35) and the NHL (4.9; range, 0-20) (Table 7) Median h-index was the same (6) in MLB and the NFL and lower (3) in the NBA and the NHL.

Discussion

To our knowledge, this is the first study of academic involvement and the research activities of orthopedic team physicians at the

high school, college, and professional levels of sport. We found that, on average, there were almost twice as many orthopedists at the collegiate and professional levels than at the high school level—likely because 72 of the 120 high schools randomly selected did not have a team physician, despite having sports teams. We can attribute this to the organizational structure of teams in a high school setting, where it is fairly common that no medically educated health care provider is readily available for the student athletes.⁵ Although the median number of orthopedists was similar at the collegiate and professional levels, the number of nonorthopedic team physicians was higher at the professional level than at the collegiate level. Although most collegiate and professional teams have an internist and an orthopedist on staff, medical staff at the professional level may also include several subspecialists from a variety of medical fields (eg, dental medicine, ophthalmology, neurology).¹⁷

Table 1. Number of Physicians per Team per Competition Level

Physician Type	Competition Level		
	High School	Collegiate	Professional
Orthopedic	1.1	2.3	2.2
Nonorthopedic	0.2	1.1	1.9

Table 2. Academic Involvement of Orthopedic Team Physicians by Competition Level^a

Competition Level	Academic Involvement, %		
	Nonacademic	Assistant Professors ^b	Full Professors
High school	80	18	2
Collegiate	64	31	5
Professional	36	49	16

^a $P < .001$.

^bIncludes associate professors, clinical instructors, etc.

Table 3. Number of Publications per Orthopedic Physician^a

Number of Publications	Competition Level					
	High School		Collegiate		Professional	
	n	%	n	%	n	%
0-5	108	81.2	198	72.0	99	36.7
6-25	18	13.5	50	18.2	89	33.0
26-50	5	3.8	13	4.7	35	13.0
51-100	1	0.8	10	3.6	26	9.6
101-200	0	0.0	3	1.1	14	5.2
>200	1	0.8	1	0.4	7	2.6

^a $P < .001$.

We found that a significantly larger proportion of orthopedists at the professional level (64%) were affiliated with academic medical centers as associate/adjunct professors and full professors compared with orthopedists at the collegiate level

Table 4. Median Number of Physicians by Professional League

Physician Type	Professional League			
	MLB (n = 30)	NBA (n = 30)	NFL (n = 32)	NHL (n = 30)
Orthopedic	2.8	1.7	2.4	2.0
Nonorthopedic	1.5	2.0	1.8	2.2

Abbreviations: MLB, Major League Baseball; NBA, National Basketball Association; NFL, National Football League; NHL, National Hockey League.

Table 5. Academic Involvement of Orthopedic Physicians by Professional League

Professional League	Academic Involvement, %		
	Nonacademic	Assistant Professors ^a	Full Professors
MLB (n = 83)	30	52	18
NBA (n = 51)	39	47	14
NFL (n = 76)	38	46	16
NHL (n = 60)	38	48	13

Abbreviations: MLB, Major League Baseball; NBA, National Basketball Association; NFL, National Football League; NHL, National Hockey League.

^aIncludes associate professors, clinical instructors, etc.

Table 6. Median (SD) Number of Publications per Professional Team Orthopedic Physician

Professional League	Median	SD
MLB	37.9	56.7
NBA	32.0	51.8
NFL	30.4	58.5
NHL	20.7	30.6

Abbreviations: MLB, Major League Baseball; NBA, National Basketball Association; NFL, National Football League; NHL, National Hockey League.

Table 7. Median (SD) h-Index for Professional Team Orthopedic Physicians

Professional League	Median	SD
MLB	7.9	8.2
NBA	6.6	8.5
NFL	8.2	8.4
NHL	4.9	5.4

Abbreviations: MLB, Major League Baseball; NBA, National Basketball Association; NFL, National Football League; NHL, National Hockey League.

(36%) and high school level (20%). The academic relationship with collegiate teams was much lower than expected. Regarding professional sports, however, this finding confirmed our hypothesis, and the explanation is likely multifactorial and historical. Moreover, the median number of publications was higher for orthopedists at the professional level (30.8) than at the collegiate level (10.7) and high school level (6). In the late 1940s and early 1950s, many orthopedic team physicians entered into contracts with major universities.⁴ For many physicians, this contractual relationship increased their prestige, and some orthopedic groups were alleged to have endorsed scholarships at those schools.⁴ Given the high level of publicity and scrutiny surrounding medical decisions at the professional level of sports, it is possible that professional sports teams specifically seek orthopedists who are well respected within academia. Moreover, contracts between universities/academic medical centers and professional teams may mandate that a faculty member from that organization provide the orthopedic/medical care for the team. This may also increase the likelihood of professional teams being paired with academic orthopedic physicians. However, such contractual agreements are made between professional teams and large private medical groups as well.

In addition to measuring quantity of publications, we used the h-index to measure their quality. Following the same pattern as the publication rate, median h-index per orthopedic team physician was significantly higher at the professional level (7.1) than at the collegiate level (2.7) and high school level (1.8). As with publication volume, this is not entirely surprising, as h-index has been shown to correlate with academic rank in other surgical specialties,¹⁸ and there was a higher percentage of academic physicians at the professional level than at the collegiate and high school levels.

At the professional level of sports, 56% of all team physicians were orthopedic surgeons. Orthopedists caring for MLB teams had the highest median number of publications (37.9), followed by the NBA (32.0), the NFL (30.4), and the NHL (20.7). One likely explanation is the higher percentage of MLB physicians affiliated with academic medical centers. Regarding the h-index, MLB and NFL physicians had the highest values (7.9 and 8.2, respectively).

Our study had several limitations. First, we may not have captured data on all the team physicians at the high school, college, and professional levels. By following a detailed protocol in identifying surgeons, however, we tried to minimize the impact of any such omissions. In addition, teams may have had many unofficial consultants acting as team physicians, whether orthopedic or nonorthopedic, and, if these physicians were not listed in an official capacity, they may have been omitted from this study. We further realize that a true measure of academic productivity should also include book chapters and books published, research grants awarded, and patents registered. By including only peer-reviewed articles, we omitted these other criteria.

To our knowledge, the data presented here represent the first attempt to quantify the academic involvement and re-

search productivity of orthopedic team physicians at the high school, college, and professional levels of sport. These data help us understand how research productivity varies by orthopedic team physicians at different levels of sport and may be useful to those considering a career as a team physician, as they can better evaluate their own productivity in the context of team physicians across different levels of competition.

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