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What is the degree of variability in formal training for pediatric orthopedic surgeons performing scoliosis surgery?

¿Cuál es el grado de variabilidad en la educación formal de los cirujanos ortopédicos pediátricos que realizan intervenciones quirúrgicas de escoliosis?

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ABSTRACT. Introduction: although pediatric orthopedic surgeons worldwide perform scoliosis surgery, the training received is variable and poorly understood. By surveying the European Pediatric Orthopedic Society (EPOS) and the Sociedad Latinoamericana de Ortopedia (SLAOTI), we aim to characterize this variability. **Material and methods:** in 2021, we distributed an anonymous online questionnaire to EPOS and SLAOTI. **Results:** 43% EPOS and 22% SLAOTI perform scoliosis procedures ($p < 0.05$). 18% EPOS and 2% SLAOTI performed > 35 procedures annually ($p < 0.05$). 70% EPOS and 27% SLAOTI received formal training in spinal deformity surgery ($p < 0.005$). **Conclusions:** results show significant differences in training and performance of scoliosis procedures between societies.

Keywords: pediatric orthopedic surgeons, scoliosis surgery, spine surgery training, EPOS, SLAOT.

RESUMEN. Introducción: aunque muchos cirujanos ortopédicos pediátricos alrededor del mundo realizan cirugías para la escoliosis, el entrenamiento es variable y poco conocido. A través de encuestar a la Sociedad Europea de Ortopedia Pediátrica (EPOS) y a la Sociedad Latinoamericana de Ortopedia (SLAOTI) queremos caracterizar esta variabilidad. **Material y métodos:** distribuimos un cuestionario anónimo en 2021 a los miembros de EPOS y SLAOTI. **Resultados:** realizan las cirugías de escoliosis 43% de EPOS, en comparación con 22% de SLAOTI ($p < 0.05$); 18% de EPOS realizó > 35 cirugías al año, en comparación con 2% de SLAOTI ($p < 0.05$); 70% de EPOS y 27% de SLAOTI recibieron capacitación formal en cirugía de deformidades de la columna ($p < 0.005$). **Conclusiones:** los resultados de este estudio subrayan las diferencias en el entrenamiento de las cirugías de escoliosis entre diferentes sociedades.

Palabras clave: cirujanos ortopédicos pediátricos, cirugía de escoliosis, entrenamiento de la cirugía de deformidades de la columna, EPOS, SLAOT.

Level of evidence: IV, case series.

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Introduction

Though pediatric orthopedic surgeons and spine surgeons routinely perform procedures for correcting scoliosis, there is no clear consensus on the standard training for those performing these procedures. Even those considered experts in the field of spinal deformity surgery disagree. Lenke elucidated why this is a challenge: the distinction between children and adults becomes muddy as those with pediatric spinal deformities already seem to have developed a relatively mature spinal column.[1] This pathology becomes more of a spectrum rather than a dichotomy, making it difficult to discern which surgeons are best suited to perform the procedure. Additionally, even within specialty training, the exposure to scoliosis cases is not uniform.

This variability in formal training, including residency programs and fellowships, was noted anecdotally at our institution and in different national and international academic conferences. We observed that more spine-trained surgeons than pediatric-trained surgeons perform scoliosis procedures in our institution; it is unclear whether this situation is unique or a current trend.

Variability in training amongst surgeons performing similar procedures is pertinent and worth elucidating. A recent study found surgeons with pediatric orthopedic surgery fellowship training who performed posterior spinal fusion saw significantly lower average blood loss (230 ± 449 vs 516 ± 517 ml; $p < 0.01\%$) and decreased need for allogeneic blood transfusion (64.31 vs 71.08%, $p < 0.01\%$) compared to surgeons without pediatric fellowship training.[2] However, this study did not compare surgeons who had spine surgery training. Another assessment from Europe showed a significant 27% increase in the self-assessed competency levels, specifically for spinal deformity, for those who had undertaken a full fellowship.[3]

Understanding the training paths surgeons take is an important and timely topic; however, the current literature does not address this well as the data available is sparse and incomplete. Spinal deformity procedures are considered high risk and understanding the high variability in training for spinal deformity procedures is critical to improving outcomes.

This study aims to elucidate and characterize the variability in training and performing spinal deformity procedures by systematically querying pediatric orthopedic surgeons in two different geographic regions of the world regarding their training and current practice concerning performing scoliosis surgery. We hypothesize there is a significant difference in training and performing spinal deformity procedures amongst pediatric orthopedic surgeons in different geographic regions.

Materials and methods

In 2021, we wrote an anonymous questionnaire that included a mixture of multiple-choice and free-response questions *(Table 1)*. The questionnaire was emailed to all the members of the European Pediatric Orthopedic Society (EPOS) and the Sociedad Latinoamericana de Ortopedia (SLAOTI). It was distributed in English for EPOS and translated into Spanish for SLAOTI.

Statistical methods

We used a two-tailed z-score test for two population proportions to determine statistical differences, setting a p-value less than 0.05 as statistically significant. No human participants and/or animals were involved. This project was exempt from the Institutional Review Board approval process.

Table 1: European Pediatric Orthopedic Society (EPOS).

Questions	Answer choices/free response		
1) Do you perform scoliosis procedures?	a) Yes	b) No	
2) Approximately how many scoliosis procedures do you perform in a typical year?	a) 0-5 b) 5-10 c) 10-15	d) 20-25 e) 25-30 f) 30-35	g) > 35
3) How many years have you been practicing as an orthopedic surgeon?	a) 0-5 b) 5-10 c) 10-15	d) 15-20 e) 20-25 f) 25-30	g) 30-35 h) > 35
4) Did you complete «formal training» in pediatric orthopedic surgery? formal pediatric orthopedic surgery training includes: pediatric orthopedic surgery fellowship, subspecialty pediatric orthopedic training, and pediatric orthopedic mentorship training	a) Yes	b) No	
5) Did you complete «formal training» in spine surgery? formal spine surgery training includes: spinal surgery fellowship, subspecialty spinal surgery training, and spinal surgery mentorship training	a) Yes	b) No	
6) Which country do you practice in?	Free response		
7) What type of hospital do you practice in?	a) Community	b) Academic	c) Private
8) Which country did you complete training in?	Free response		

Table 2: Questions with responses and statistics.

Survey questions *(Table 1)*	EPOS N = 53 n (%)		SLAOTI N = 55 n (%)		p	95% Confidence interval
1) Do you perform scoliosis procedures?	**Yes 23 (43)**		**Yes 12 (22)**		**< 0.05**	**0.04 – 0.39**
2) Approximately how many scoliosis procedures do you perform in a typical year?	**0-5**	**26 (53)**	**0-5**	**46 (87)**	**< 0.05**	**-0.50 – -0.17**
	5-10	3 (6)	5-10	2 (4)	> 0.05	-0.06 – 0.11
	10-15	2 (4)	10-15	2 (4)	> 0.05	-0.07 – 0.08
	15-20	5 (10)	15-20	1 (2)	> 0.05	-0.01 – 0.18
	20-25	2 (4)	20-25	0 (0)	> 0.05	-0.01 – 0.10
	25-30	1 (2)	25-30	0 (0)	> 0.05	-0.02 – 0.06
	30-35	1 (2)	30-35	1 (2)	> 0.05	-0.05 – 0.06
	> 35	**9 (18)**	**> 35**	**1 (2)**	**< 0.05**	**0.05 – 0.28**
		Skipped: 4		Skipped: 2	N/A	N/A
3) How many years have you been practicing as an orthopedic surgeon?	0-5	6 (11)	0-5	10 (18)	> 0.05	-0.20 – 0.06
	5-10	10 (19)	5-10	15 (27)	> 0.05	-0.24 – 0.07
	10-15	7 (13)	10-15	14 (25)	> 0.05	-0.27 – 0.02
	15-20	7 (13)	15-20	5 (9)	> 0.05	-0.08 – 0.16
	20-25	7 (13)	20-25	4 (7)	> 0.05	-0.05 – 0.17
	25-30	6 (11)	25-30	3 (5)	> 0.05	-0.05 – 0.16
	30-35	3 (6)	30-35	2 (4)	> 0.05	-0.06 – 0.10
	> 35	7 (13)	> 35	2 (4)	> 0.05	-0.01 – 0.20
		Other (0)		Other (0)	N/A	N/A
4) Did you complete «formal training» in pediatric orthopedic surgery?	Yes 44 (83)		Yes 29 (89)		> 0.05	-0.91 – 0.07
5) Did you complete «formal training» in spine surgery?	**Yes 37 (70)**		**Yes 15 (27)**		**< 0.05**	**0.25 – 0.60**
6) Which country do you practice in?	*Table 3*		*Table 3*		N/A	N/A
7) What type of hospital do you practice in?	**Community**	**12 (23)**	**Community**	**26 (47)**	**< 0.05**	**-0.42 – -0.07**
	Academic	37 (70)	Academic	30 (55)	> 0.05	-0.03 – 0.33
	Private	**10 (19)**	**Private**	**29 (53)**	**< 0.05**	**-0.51 – -0.17**
8) Which country did you complete training in?	*Table 4*		*Table 4*		N/A	N/A

EPOS = European Pediatric Orthopedic Society. SLAOTI = Sociedad Latinoamericana de Ortopedia.
* Statistically significant results are bolded, and clinically significant results are underlined.

Results

The survey was sent to the 365 members of SLAOTI and 593 members of EPOS. We received 53 responses from EPOS and 55 from SLAOTI, which were then analyzed *(Table 2)*. The corresponding response rate was 15.1% for SLAOTI and 8.9% for EPOS.

There were significantly more EPOS respondents performing scoliosis procedures compared to SLAOTI respondents (43 vs 22%) ($p < 0.05$). There was a noteworthy difference in the annual volume of scoliosis performed. There were more SLAOTI respondents only performing 0-5 annual cases (87 vs 53%) ($p < 0.05$). On the other side of the spectrum, there were more EPOS surgeons performing more than 35 annual cases (18 vs 2%) ($p < 0.05$) *(Table 2)*.

We found a significant difference in the number of years that respondents had been practicing orthopedic surgery with the group from SLAOTI being earlier in their careers, demonstrated by 70% of SLAOTI respondents having been in practice for 0 to 15 years, compared to only 43% of the EPOS respondents. The percentage of respondents who have practiced orthopedic surgery for more than 35 years was also different with 13% for EPOS and only 4% for SLAOTI ($p < 0.05$) *(Table 2)*.

Furthermore, we found that 70% of EPOS respondents completed formal spine surgery training compared to only 27% of SLAOTI respondents ($p < 0.05$). Interestingly, 83% of EPOS respondents completed formal training in pediatric orthopedic surgery, compared to 89% of SLAOTI respondents ($p > 0.05$) *(Table 2)*.

Regarding the type of hospital where the surgeons were practicing, more SLAOTI respondents practice in community-based hospitals (47 vs 23%) ($p < 0.05$). When asked about academic hospitals, 70% of EPOS respondents are part of academic hospitals compared to 55% from SLAOTI ($p > 0.05$). Lastly, more SLAOTI participants

work in private hospitals compared to EPOS participants (53 vs 19%) ($p < 0.05$) *(Table 2)*.

Regarding geographic spread, the EPOS respondents covered 25 countries and the SLAOTI respondents covered 15 *(Table 3)*. As far as training, EPOS respondents trained in 10 different countries and SLAOTI respondents trained in 14 *(Table 4)*. Of note, we found that 3 respondents from SLAOTI and EPOS trained in the USA *(Table 4)*.

Discussion

Our research focused on understanding the variability in training and practicing spinal deformity surgery amongst pediatric orthopedic surgeons in two different geographic regions (Europe and Latin America). It resulted in multiple statistically significant as well as clinically significant differences.

Almost double the proportion of pediatric orthopedic surgeons from Europe perform scoliosis procedures (EPOS 43% vs SLAOTI 22%). A greater percentage of EPOS participants performed more than 35 annual scoliosis procedures (EPOS 18% vs. SLAOTI 2%), and a greater percentage of SLAOTI members performed only 0-5 annual cases (SLAOTI 87% vs EPOS 53%). To be considered a high-volume pediatric spine surgeon, most institutions consider performing more than two fusions per month as the standard, amounting to 24 per year. Our results indicate that only 22% of EPOS and 4% of SLAOTI members would meet this criterion *(Table 2)*.

Furthermore, we found clinically significant differences between the groups, such as the percentage of respondents who performed 15-20 scoliosis procedures, indicating that those in EPOS have a higher volume of scoliosis procedures than those in SLAOTI *(Table 2)*. One of the many possible reasons behind this is the increasing cost of scoliosis surgery and the different insurance options afforded to patients in these different regions.

These differences all indicate that the pediatric orthopedic surgeons in EPOS are generally more likely to perform scoliosis procedures, and at a higher volume compared to their SLAOTI counterparts.

Interestingly, a greater percentage of EPOS respondents have been practicing for at least 35 years, which may reflect population demographics for both regions *(Table 2)*.

The annual quantity frequency of performing scoliosis procedures is an important parameter when assessing the training of surgeons; as studies show a positive correlation between outcomes and surgical experience and volume.[4]

An optimal training pathway for surgeons performing spinal deformity surgery could maximize opportunities to increase surgical experience. A recent study showed that the level of training of the first assistant did not impact the clinical outcomes of scoliosis surgery.[5] One strategy to increase surgical exposure while minimizing the risk to patients is to pair a junior surgeon with a senior one for a defined time during the early part of their career to increase the junior attending's volume without compromising the patient outcomes.

We found a significant difference in the percentage of formal training in spine surgery, by geographic region, with 70% of EPOS respondents and only 27% of SLAOTI respondents stating that they had undergone formal training in spinal deformity procedures, meaning they participated in adult spine fellowships. We also found high percentages

Table 3: Countries practiced in (free responses to question six).

Society	Countries (# of respondents)	Total countries
EPOS	Albania (1), Belgium (1), Bulgaria (1), Canada (1), Croatia (1), Denmark (1), Egypt (1), France (7), Germany (1), Greece (3), Israel (2), Italy (7), Lebanon (1), Lithuania (1), Netherlands (2), Palestine (1), Portugal (2), Romania (1), Spain (3), Sweden (1), Switzerland (5), Turkey (2), Ukraine (2), United Kingdom (1), United States of America (4)	25
SLAOTI	Argentina (10), Chile (8), Colombia (3), Costa Rica (1), Cuba (1), Dominican Republic (3), Ecuador (4), Guatemala (1), Mexico (10), Nicaragua (2), Paraguay (5), Peru (2), Spain (1), United States of America (1), Venezuela (1)	15

EPOS = European Pediatric Orthopedic Society. SLAOTI = Sociedad Latinoamericana de Ortopedia.

Table 4: Countries trained in (free responses to question eight).

Society	Countries (# of respondents)	Total countries
EPOS	Bulgaria (1), France (2), Italy (2), Portugal (1), Romania (1), Spain (2), Sweden (1), Switzerland (1), United Kingdom (1), United States of America (3)	10
SLAOTI	Argentina (12), Brazil (2), Canada (1), Chile (7), Colombia (3), Costa Rica (1), Cuba (1), Guatemala (1), Italy (1), Mexico (18), Paraguay (1), Peru (1), United States of America (3), Venezuela (4)	14

EPOS = European Pediatric Orthopedic Society. SLAOTI = Sociedad Latinoamericana de Ortopedia.

of both groups who had received formal training in pediatric orthopedic surgery, with 83% of EPOS respondents and 89% of SLAOTI respondents reporting formal training in pediatric orthopedic surgery *(Table 2)*.

Given that 83% of EPOS respondents have formal training in pediatric orthopedic surgery and 70% in spinal surgery, the implication is that most EPOS respondents have received formal training in both spine surgery and pediatric orthopedic surgery-performing two fellowships *(Table 2)*. In contrast, 89% of SLAOTI respondents received formal pediatric orthopedic surgery training, and only 27% received formal spinal surgery training. We recognize that the way the question was posed, i.e. Did you complete «formal training» in spine surgery? Formal spine surgery training includes: spinal surgery fellowship, subspecialty spinal surgery training, and spinal surgery mentorship training; may have been ambiguous and could have been answered differently given individual circumstances *(Table 1)*.

Despite 70% of EPOS respondents having formal training in scoliosis surgery only 43% perform the procedures. In contrast, only 27% of SLAOTI respondents had formal scoliosis training, but 22% of them do perform scoliosis procedures *(Table 2)*. This may imply a redundancy in training that could offer opportunities to perform procedures that surgeons are more likely to perform in their careers.

To provide more context as to what these differences entail, it is essential to understand the characteristics and implications of the training offered in Europe and Latin America. In order to become a pediatric orthopedic surgeon in Europe, a degree in medicine is typically acquired by completing a 6-year University programme.[6] After obtaining a medical degree, students start a specialty training program, which generally lasts six years and, depending on the country, has a different number of cases required and a content exam.[7] Upon graduating from specialty training, they may take a two-part European Board of Orthopedics and Traumatology (EBOT) fellowship examination to be qualified to practice in many countries in Europe.[7] Successful completion of the exam results in the resident being named a Fellow of the European Board of Orthopedics and Traumatology (FEBOT).[8]

In most parts of Latin America, a degree in medicine is acquired after completing a 6-year University programme. The final year serves as an internship that involves rotations in significant areas of care (internal medicine, general surgery, pediatrics, obstetrics, and gynecology).[7,9] Like the European model, postgraduate training involves specialty training programs that can take four to five years to complete.[9] Graduates are granted certification as specialists, which can vary depending on the particular country.[9] An application can include requirements such as a minimum of 5 years of surgical training, a passing score on theoretical and practical examinations, and lists and numbers of operations performed in the past year.[9]

After completing specialty training, there are opportunities in Europe and Latin America to pursue subspecialty training, both in pediatric orthopedic surgery and in spine surgery.[7] Of note, there were respondents from both EPOS and SLAOTI that were trained in the United States of America. Our findings indicate that members of EPOS are more likely to complete two formal training programmes, one in pediatric orthopedic surgery and one in spine surgery, than their counterparts in Latin America. It is noteworthy that although there were significantly fewer respondents in SLAOTI who received formal training in spine surgery than those in EPOS, more respondents in SLAOTI received formal training in pediatric orthopedic surgery. These differences may reflect the variable accessibility of specific subspecialty training between regions. Other factors such as regional interest in the subspecialty, opportunities and compensation could play a role in this difference.

Given the similarity in the training pathways between Europe and Latin America, it is remarkable that most respondents from EPOS have completed two subspecialty training programmes. It is possible that in Europe, completing two specialty programmes could be more advantageous to surgeons by allowing them to perform a broader range of surgeries or perhaps increasing compensation. It is also possible that spine surgery training is more accessible in Europe, given application requirements and commitments. These possibilities give way to potential research that can help to elucidate better why these differences in training occur and address these differences to ensure that patient safety and optimal outcomes remain at the forefront of the profession.

The differences between the groups regarding hospital type could reflect differences in the healthcare systems of the countries where the respondents practice. In Europe, some countries have begun expanding private practices; however, overall research indicates that the private sector compared to the public sector, is similar or less efficient, less accessible, and not significantly different in the quality of care.[10] This may explain the significantly lower proportion of EPOS respondents working in private hospitals. Other research also indicates a growth of community hospitals in Europe, explaining the higher percentage of EPOS respondents practicing in community hospitals.[11] From the survey data, most EPOS respondents worked in academic hospitals, which supports that in Europe, most pediatric orthopedic surgeons work in academic hospitals. The type of hospital where surgeons ultimately practice is often the result of their training, as different types of hospitals can expose surgeons to different environments. For instance, a study conducted in New York suggests that surgeons who practice in larger hospitals have a higher volume of surgeries, which leads to higher surgical experience and potential improved surgical outcomes.[12]

The strengths of this study include its anonymity and simplicity, allowing for easy comparative analysis between pediatric orthopedic surgery societies. Additionally, the study has a diverse scope, given that the survey was written

in two languages and was distributed to two global regions. This study's limitations include the small sample size and the ambiguous terms used to define formal training. To address this ambiguity, future studies can be conducted to investigate what exactly is meant by formal training and then observe how it may vary in different regions of the world. Most importantly, surveying a group representing the entire world would be ideal. However, we could not query the Pediatric Orthopedic Society of North America (POSNA) due to an organizational policy of not, nor did we query the Asia-Pacific Pediatric Orthopedic Association (APOA) or the Scoliosis Research Society (SRS) as we did not have access to them. Investigating the trends for the members of these societies remains a valid and essential future step for research.

Additionally, it would be important to directly compare the surgical outcomes of scoliosis procedures performed by surgeons who are formally trained in spine surgery, surgeons who are formally trained in pediatric orthopedic surgery, and surgeons who have dual training. The current literature suggests better postoperative outcomes for those trained in pediatric orthopedic surgery, but the impact of training in spine surgery is still an area of research.

Conclusions

The results of this study highlight the existence of important differences in training and performing scoliosis procedures for pediatric orthopedic surgeons practicing in Europe and Latin America.

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