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Cataract surgical training in Poland: analysis of the European board of ophthalmology survey results

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Abstract

Backgrounds/objectives This study, part of a series, aims to present and analyze the results of the Polish cohort in a European Board of Ophthalmology (EBO) survey on cataract surgical (CS) training in Europe, highlighting national traits and contributing to the discussion on standardizing ophthalmology training.

Materials and methods This study analyses the survey results of Polish participants in the EBO examinations (2018–2022) and compared them with the largest groups of candidates (Germany, France, Swiss and Spain).

Results Out of 144 candidates, 79 (55%) answered the questionnaire. Most (70.9%) had taken the EBO exam between 2021 and 2022, with the vast majority of study participants being women (77.2%) with a median age of 34 years and came from 9 different voivodeships. Notably, 25.4% stated that they had carried out 10 or more training sessions on virtual reality simulator, 13.9% on synthetic eyes and 12.7% on animal eyes. There was a significant difference in the concrete use of SBME (more than ten sessions regardless of the simulation tool) between men and women (55.6% versus 23% respectively, $p=0.008$). A notable discrepancy was observed between participants with 10 or more training sessions and those without specific training in four key areas: self-assessed confidence and ability to perform cataract surgery ($p=0.003$), handling complications like posterior capsular tear ($p<0.001$) and in performing corneal sutures ($p=0.015$). Less than half (40.5%) of respondents had not performed any steps of cataract surgery on patients during their residency. Unlike in the EBO results, there were no gender differences found.

Discussion The results show a geographically homogenous group with an overrepresentation of Warsaw. Polish residency training is a hybrid model ensuring that all residents receive uniform surgical training. After completing their residency, Polish ophthalmologists are subsequently categorized into either surgical specialists or clinical practitioners.

Keywords Surgical training, Phacoemulsification, Survey, Europe, Simulation, Poland

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Introduction

Cataract surgery (CS) is the most frequently performed surgical procedure in the world, with an estimated 20 million procedures performed annually [1], representing 85% of all ophthalmic surgeries [2]. Phacoemulsification, the primary technique for CS over the past three decades, is considered the gold standard for cataract treatment [3]. In Poland, the most common cause of eye-related hospital admission is age-related cataracts. With more than 320,000 procedures carried out in 2023, cataract surgery (CS) is the most frequently performed surgical procedure in the country [4]. According to the projection of Statistics Poland (Główny Urząd Statystyczny, GUS), the population aged 60 and more in Poland will grow gradually by 2060. In 2060, 11.9 million older people are expected to live in Poland, i.e. 21% more than in 2022. Older people are supposed to constitute about 38.3% of the total population of Poland [5]. These data illustrate the importance and challenge of training enough surgeons in CS to meet future demand.

Over the past decade, there has been a notable shift in the evolution of surgical education programs at the local, national, and international levels [6–9]. These changes include the implementation of work-hour restrictions in various jurisdictions, constraints that limit operating room accessibility [10], and increased litigation against physicians. Globally, these factors have resulted in a reduction in both operative and educational opportunities. The transmission of technical skills constitutes one of the most important tasks of a surgeon [11]. However, despite training, numerous studies have revealed a decline in performance over time and an alteration in the knowledge of transfer [12–14]. “See one, do one” is no longer appropriate for educating health professionals to perform complex procedures [15]. This highlights the necessity to re-examine our pedagogical approach to acquiring technical skills. So, educating cataract surgeons presents a dual challenge: training a sufficient number of cataract surgeons, while assuring their competency. In order to resolve these issues, it is essential to analyse the existing teaching model and collate the residents’ learning experiences, learning expectations, and learning needs.

Currently, speciality training in ophthalmology in Poland is carried out according to two specialisation programs, depending on the year of beginning of residency. The new 4-year program started in 2023, and the former 5-year program was established in 2019. Each program contains a list of practical skills. The surgical procedures required are almost the same in both programs. The list of practical skills includes, among others, subconjunctival, periocular and intravitreal injections, local anaesthesia for ophthalmic surgeries, retinal photocoagulation, laser capsulotomy, laser iridotomy, removals of

xanthelasma, warts, and tumours that do not require free or sliding flap, chalazion excision, conjunctival suturing, pterygium excision, and tarsorrhaphy. Since 2023, the new program adds collecting a cornea from a corpse. According to the specialisation program, Polish trainees are not required to perform cataract surgery as primary surgeon. However, the program from 2019 states that the resident must observe, assist, or perform cataract surgeries, strabismus surgeries, enucleations, eyelid surgeries, glaucoma surgeries, vitrectomies, conventional retinal detachment surgeries, and conjunctival surgeries. In the new program, requirements are lower, and mandatory assistance comprises solely cataract, strabismus, and glaucoma surgeries.

During specialisation, residents must record online the completion of individual elements of the specialisation program on the electronic specialisation card. The specialisation program in Poland is divided into internships and courses. The resident can complete the internships in his or her centre if it has the appropriate accreditation or in a centre of choice after consultation with the supervisor. Similarly, each trainee signs up for mandatory courses, some of which can be taken online. Approval of all required internships and courses in the specialisation book is necessary to validate the entire training. The resident also records the number of surgical procedures performed in the electronic specialisation book. The minimum number of procedures is clearly defined for some skills, e.g., retinal photocoagulation; for others, such as assisting in cataract surgery, it is defined as “at the discretion of the supervisor”. Considering all the above, it should be noted that the participation of Polish residents in surgical procedures, especially intraocular ones, is highly variable and depends on the selected training centre.

A European Board of Ophthalmology (EBO) survey conducted between 2018 and 2022 shows that CS training varies significantly across Europe [7]. The results highlighted two distinct training models: ‘surgery for all’ (all residents received CS training) and ‘high volume surgeons’ (CS training is reserved for a few after the residency), reflecting different approaches to surgical opportunities for residents. The survey also revealed a gender disparity, with female trainees performing fewer surgeries ($p=0.04$) and reporting lower self-confidence ($p=0.028$). There was a strong correlation between the number of surgeries performed and residents’ confidence in their surgical abilities, with correlation coefficients of 0.769 ($p<0.001$) and 0.862 ($p<0.001$) for partial and total operations, respectively. While simulation-based medical education (SBME) is crucial for surgical training, the survey found no significant correlation between using simulation tools and confidence in performing cataract surgery or managing complications as a primary surgeon.

Wet labs were the preferred method for simulation training, followed by virtual reality simulators (VRS).

This study is part of a collaborative series currently being published in various journals across European countries, thanks to the cooperation of their respective professional societies. It will conduct an in-depth subgroup analysis of the Polish cohort, placing their results within the broader European perspective. It will focus on Polish ophthalmology residents' training experiences, self-evaluation, and confidence levels. The goal is to thoroughly examine the Polish-specific data from the EBO survey to identify unique regional traits and contribute to the ongoing conversation about standardising and enhancing ophthalmological training throughout Europe.

Methods

Questionnaire creation, dissemination, and data collection

An anonymous survey entitled “*Cataract Surgery Training and Learning among European Residents*” was created. It comprised 23 questions divided into five sections. The final version of the questionnaire was distributed via an electronic platform (SurveyMonkey Europe UC, Dublin, Ireland). Email invitations were sent in May of 2022 by the EBO office to all candidates who had taken the EBO Diploma Examination as residents between 2018 and 2022, followed by two reminder emails. Participant identification was limited to their city and country. The survey informed all participants about the study's

purpose, their right to withdraw at any time, and that their data would be collected, anonymised, aggregated and analysed to be part of a publication. Informed consent to participate was obtained from all of the participants in the study. The survey concluded on July 15, 2022. This study was approved by the Ethics Committee of the French Society of Ophthalmology (IRB 00008855 Société Française d'Ophtalmologie IRB#1). The survey used in this study has already been published along with the results of the European data collection [7].

Polish data collection

The Polish data was divided into subgroups according to regional origin (*voivodeships*) for the statistical analysis.

Statistical analysis

The descriptive statistical analysis of the quantitative variables was carried out by specifying each variable's position and dispersion parameters. The normal distribution of the data was tested using the Shapiro-Wilk test and quantile-quantile diagrams. The qualitative variables were described by specifying the number and proportion of the individual modalities in the sample. Whenever appropriate, cross-tabulations were created. The inferential analysis of the qualitative variables was carried out using either a Chi-2 test or an exact Fisher test, depending on the theoretical frequencies in the contingency tables. Post-hoc tests were performed using the Benjamini and Hochberg alpha risk correction (false discovery rate). Comparisons of quantitative variables between groups were performed either with a Student's t-test (if the primary variable was normally distributed) with possible correction for heterogeneity of variances (Welch test) or with a non-parametric test (Mann-Whitney-Wilcoxon test). Post-hoc tests were performed with the Bonferroni-Holm alpha risk correction (false discovery rate). Two quantitative variables were compared using Spearman's rank correlation rho test. Multivariate analyses were performed using gender, handedness (right- or left-handed), surgical experience outside the EU, duration of residency, and year of residency as explicit variables. A p-value < 0.05 denoted the significance level. The analyses were carried out using R software (version 4.2.1).

Table 1 Characteristics of the participants

Number of contacted candidates	144
Number of respondents	79
Response rate (%)	55
Number of voivodeships	9
Number of cities	15
Median age in years (Q1,Q3)	34 (32;35)
Gender, n (%)	
Female	61 (77.2)
Male	18 (22.8)
Handedness, n (%)	
Right-handed	71 (89.9)
Left-handed	3 (3.8)
Ambidextrous	5 (6.3)
Year of EBO examination, n (%)	
2018	3 (3.8)
2019	20 (25.3)
2020	
2021	38 (48.1)
2022	18 (22.8)
2018–2019	23 (29.1)
2021–2022	56 (70.9)

This table presents a detailed overview of the demographic characteristics of the participants from the Polish cohort. The group of participants includes representatives from 9 out of 16 Poland's voivodeships, representing 16 different cities

Results

Background characteristics of respondents

The survey was sent to 144 Polish ophthalmologists who had passed the EBO exam (FEBO Fellow of the European Board of Ophthalmology) and met the participation criteria. Seventy-nine responses were received from Poland, with a response rate of 55%. The characteristics of the respondents are summarised in Table 1.

Women constituted the vast majority of respondents, making up 77.22% ($N=61$) of all responses. The median

age of respondents was 34 years. The vast majority (89.87%) were right-handed, with five reporting ambidexterity (6.3%). The duration of the residency was 5 years.

56 (70.89%) participants took the EBO exam in 2021–2022, while the remaining 23 (29.11%) did so in 2018–2019. The EBO exam was cancelled in 2020 due to the pandemic.

Nine out of 16 voivodeships are represented in our cohort. The Masovian voivodeship containing Poland's capital, Warsaw, Lower Silesia and the Greater Poland Voivodeship accounted for more than half of the total respondents (53.2%). However, information on the exact place of further training could not be obtained from 14 participants (17.7%).

Training in cataract surgery

Simulation-based medical education (SBME)

Regardless of simulation tools, the median number of training sessions was 5 (min 5; max 30). The most commonly used simulation support was animal eyes. The percentage of respondents who had completed ten or more training sessions using animal eyes (wet labs), synthetic eyes (dry labs), or VRS was 25.4%, 12.7%, and 13.9%, respectively. There was no significant geographic clustering or differences among respondents who reported more than ten simulation-based training sessions (regardless of simulation tools, $p=0.188$).

There was a significant difference in the concrete use of SBME (more than ten sessions regardless of the simulation tool) between men and women (55.6% versus 23% respectively, $p=0.008$). There was also a moderately significant correlation between the number of CS done and using the SBME ($\rho: 0.406$, $p<0.001$) [16].

There was a significant difference in self-assessment and confidence in performing cataract surgery ($p=0.003$), in performing corneal suture ($p=0.015$) and complications like posterior capsular tear ($p<0.001$) between the group of participants with ten or more training sessions and those with no specific training sessions.

Surgical training “hands-on”

Thirty-two respondents (40.5%) had not performed cataract surgery on patients during their residency in Poland. No significant geographical differences or differences based on gender were found here.

With 59.5% ($N=47$) of the study participants having started training in cataract surgery during their residency, most respondents (48.9%) stated that the first steps of practical cataract surgery were performed in the two last years of their residency. Of note, seven respondents (14.9%) stated they started their surgical cataract training in the first and second years of residency. Phacoemulsification was the most common procedure (93.3%), followed by manual small incision cataract surgery

(MSICS, 3.3%) and extracapsular extraction (3.3%). The first learned steps were corneal incision (61.7%), antibiotic injection (46.8%), viscoelastic devices injection (40.4%), removal (40.7%) and intraocular lens (IOL) insertion (19.1%). The individual steps of phacoemulsification that were perceived as the most difficult to learn was the capsulorhexis, with 66.0% at the beginning of the training and 4% at the end of the residency. The average reported number of partially and entirely performed operations was 25.3 and 19.1, respectively, significantly below the European mean of 75.6 and 80.7 ($p<0.001$). The number of cataract surgeries performed and confidence levels at the end of residency are presented in the Table 2. Furthermore, the results reveal a relatively low self-confidence (0: no confidence to 10 complete confidence) in performing simple cataract surgery (rating: 1.0), complex cataract surgery (0.6), managing posterior capsule rupture (2.2) and corneal suturing (0.4), which is also below the European average (2.4 to 4.2). Significant regional differences were not observed. The Spearman coefficient for the correlation between the number of partial or entirely performed during specialist training and the confidence to perform cataract surgery as the main surgeon was found to be important at 0.720 ($p<0.01$). Similar significant correlations were found with the confidence to perform complex cases (0.790; $p<0.01$), capsular rupture (0.582; $p<0.01$) or corneal sutures (0.599; $p<0.01$).

Only 4 (5.1%) respondents had practiced cataract surgery on patients outside Poland during their residency. The mentioned countries were India and the UK. This experience abroad did not significantly correlate with the confidence to do a CS as a first surgeon ($p=0.368$).

The respondents rated the importance of a fellowship for surgical training at 8.7 ± 2.3 (with ten being the most important). Interestingly, there was no significant difference in the rating between those who performed CS during their residency and those who did not. Moreover, there was no correlation between the number of carried out CS and the rated importance of a fellowship.

In contrast to the European cohort, no significant gender differences were observed for any of the variables analysed, both in the univariate and the multivariate analysis (see Table 3). However, female respondents reported fewer CS procedures than their male colleagues and were less confident in their surgical skills than male respondents. However, they reported a slightly higher confidence in managing posterior capsular ruptures than their male counterparts did. Interestingly, unlike in the European cohort, taking the EBO exam before 2020 correlated significantly with the number of complete cataract operations performed, their confidence in managing difficult cases and their confidence in performing corneal sutures at the end of their residency in the multivariate analysis. Regarding handedness, the only statistically

Table 2 Number of cataract surgery performed and confidence levels at the end of residency

Voivodships	Number of respondents	Number of cities	Number of CS procedures partially performed	Number of CS procedures totally performed	Confidence to perform CS	Confidence to perform challenging cases of CS	Confidence to manage PCR	Confidence to place corneal stitches
	<i>n</i>		Mean number (SD)		Mean score (SD)			
Lesser Silesia	11	2	44.6±87.1	42.3±87.7	1.3±2.7	1.3±2.7	2.6±3.0	0.8±2.4
Subcarpathian	2	1	22.5±17.7	10.0±0.0	0.0±0.0	0.0±0.0	1.5±2.1	0.0±0.0
Greater Poland	9	3	18.3±12.5	10.0±0.0	0.6±1.1	0.1±0.3	1.3±2.2	0.1±0.3
Łódź	2	1	22.5±17.7	10.0±0.0	3.0±4.2	1.0±1.4	5.0±1.4	2.0±2.8
Lublin	2	1	22.5±24.7	22.5±24.7	3.0±4.2	2.0±2.8	0.5±0.7	1.0±1.4
Mazovia	22	1	26.8±29.7	16.7±16.1	1.6±2.5	0.8±1.7	2.5±2.7	0.6±1.3
Lesser Poland	7	1	13.6±9.5	10.0±0.0	0.4±1.1	0.0±0.0	1.7±2.4	0.0±0.0
West Pomerania	4	2	16.3±12.5	10.0±0.0	0.3±0.5	0.0±0.0	2.3±2.1	0.0±0.0
Silesia	6	3	10.0±0.0	10.0±0.0	0.2±2.1	0.2±0.4	1.8±2.6	0.2±0.4
Poland	79	15	26.5 (48.7)	19.7 (41.8)	1.0 (2.1)	0.6 (1.5)	2.2 (2.6)	0.4 (1.2)
Europe	821	248	75.6 (90.9)	80.7 (100.6)	4.1 (3.9)	3.2 (3.4)	4.2 (3.7)	2.4 (3.0)

CS: cataract surgery. NA: not applicable. PCR: posterior capsule rupture. SD: standard deviation

Considering the responses of all respondents, the mean number of CS fully performed (from the first to the last step alone) during residency was 19.7 ± 41.8 and the number of CS partially performed (when at least one step was done by the senior surgeon) during residency was 26.5 ± 48.7 . The confidence score (scored from 0 to 10) for performing simple CS cases, challenging cases and managing PCR as first surgeon was 1.0 ± 2.1 , 0.6 ± 1.5 and 2.2 ± 2.6 respectively. Some voivodships have such small numbers of respondents and such low response rates, that interpretation of the regional results of reported confidence is questionable

significant difference was the number of total CS procedures performed during residency ($p=0.047$ in the multivariate analysis). Ambidextrous individuals reported having performed significantly more procedures on average.

Discussion

This study aimed to investigate differences in surgical training in the field of CS and analyse their correlation with practical experience, self-confidence, and self-assessment of young ophthalmologists. In particular, a Polish sub-cohort was studied compared to a broader European cohort.

In recent years, Poland has provided one of the largest groups of candidates for the European Board of Ophthalmology (EBO) examination, which is also reflected in the results of this Europe-wide survey. The response rate of the Polish residents is 55%, which is higher than the European average of 45.5%, is commendable and lends credibility to the findings. This can be attributed to the fact that in Poland, residents can select either the State Specialisation Examination (Państwowy Egzamin Specjalizacyjny, PES) or the EBO examination. The PES comprises two distinct components: a written examination and an oral interview [17]. The inaugural examination of the education committee of the EBO was held in Milan on 24 and 25 June 1995, preceding the European Society Congress. Since then, the examinations have been conducted annually in Paris. In 1995, 44 candidates took the examination, with 48 teachers volunteering as examiners. Both candidates and examiners represented the different countries of the European Union at that time, except for Portugal [18]. According to the EBO records,

Polish candidates have regularly participated in the EBO Comprehensive Exam since 2008. Due to the COVID-19 pandemic, the EBO examination was cancelled in 2020. Therefore, no Polish candidate sat the examination that year. Like their European counterparts, most participants undertook the EBO exam between 2021 and 2022, coinciding with the post-COVID era that introduced a diversified exam format, including remote examination options. It is plausible that this new flexibility contributed to the heightened interest in taking the exam.

On average, in line with their European counterparts, Polish respondents are in their third decade of life, and approximately 90% of respondents are right-handed. In contrast to the European cohort, there is a strong preponderance of female participants (77.2% versus 55.9%) and no statistically significant difference was found in the reported number of procedures. Although gender differences in the number of cataract surgeries performed were not statistically significant in our Polish cohort, the observed trend toward more procedures among males, combined with the significant difference noted in the European cohort, suggests that this discrepancy may be due to inadequate statistical power, given the smaller number of male participants (18 vs. 61 females). The feminisation of the profession in Poland concerns all physicians, with women accounting for 59% of the workforce. Moreover, the feminisation of the profession may also be attributed to the influence of biological sex on perceptual and reactive capabilities. A comprehensive review of the literature on surgical skills revealed that biological sex exerts a significant impact on perceptual and reactive abilities. Indeed, women have demonstrated superior proficiency in finger dexterity, whereas men have been

Table 3 Analysis of subgroups according to predictive factors and their influence on the number of CS performed and confidence scores

Variates	Number of CS partially performed during residency		Number of CS totally performed during residency	Confidence to perform CS at the end of residency		Confidence to perform challenging cases of CS at the end of the residency	Confidence to manage PCR at the end of residency	Confidence to perform a corneal suture at the end of the residency
	Mean number ± SD	P value		Mean score ± SD	P value			
Gender	Woman	23.0 ± 40.7	17.0 ± 30.1	0.9 ± 1.9	0.5 ± 1.3	2.3 ± 2.6	0.3 ± 0.9	
	Man	39.1 ± 70.7	28.9 ± 68.1	1.4 ± 2.6	1.0 ± 2.2	2.1 ± 2.7	0.8 ± 1.9	
Dominant hand	P value univariate	0.353	0.448	0.501	0.425	0.467	0.184	
	P value multivariate	0.453	0.617	0.823	0.515	0.478	0.408	
Surgery experience outside Europe	Right-handed	23.6 ± 39.2	16.4 ± 28.1	0.9 ± 1.9	0.5 ± 1.3	2.1 ± 2.6	0.3 ± 0.9	
	Left-handed	18.3 ± 14.4	18.3 ± 14.4	2.0 ± 3.5	1.3 ± 2.3	2.0 ± 1.7	0.7 ± 1.2	
Residency duration	Ambidextrous	73.0 ± 127.4	68.0 ± 129.7	2.4 ± 3.3	1.6 ± 3.6	4.2 ± 3.3	1.8 ± 3.5	
	P value univariate	0.733	0.392	0.206	0.819	0.240	0.244	
EBO examination	P value multivariate	0.098	0.047	0.297	0.335	0.197	0.057	
	Yes	10.0 ± 0.0	26.3 ± 32.5	1.3 ± 1.5	0.3 ± 0.5	2.5 ± 3.3	0.5 ± 0.6	
Residence	No	27.4 ± 49.9	19.4 ± 42.4	1.0 ± 2.1	0.6 ± 1.6	2.2 ± 2.6	0.4 ± 1.3	
	P value univariate	0.212	0.369	0.373	0.988	0.944	0.135	
EBO examination	P value multivariate	0.276	0.893	0.977	0.480	0.915	0.782	
	< 5 years	22.5 ± 17.7	10.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	2.5 ± 3.5	0.0 ± 0.0	
Residence	≥ 5 years	26.7 ± 49.3	20.0 ± 42.3	1.0 ± 2.1	0.6 ± 1.6	2.2 ± 2.6	0.4 ± 1.2	
	P value univariate	0.588	0.628	0.482	0.473	0.948	0.526	
EBO examination	P value multivariate	0.986	0.914	0.511	0.657	0.873	0.826	
	Before 2020	27.6 ± 61.2	23.7 ± 60.5	0.7 ± 1.8	0.6 ± 1.7	2.2 ± 2.52	0.5 ± 1.7	
EBO examination	After 2020	25.2 ± 37.4	18.1 ± 31.5	1.3 ± 2.2	0.6 ± 1.5	2.2 ± 2.7	0.4 ± 1.0	
	P value univariate	0.981	0.716	0.450	0.877	0.982	0.591	
EBO examination	P value multivariate	0.857	0.602	0.507	0.961	0.993	0.460	

This table presents an analysis of certain variables (gender, dominant hand, residency duration, surgical experience outside Europe, year of taking the EBO exam) and their association with the number of surgeries performed and confidence scores. In contrast to the European cohort, no significant gender differences were observed for any of the variables analysed. Anecdotally, self-declared ambidextrous person reported a significant higher number of CS totally performed during the residency

shown to excel in pursuit tracking, repetitive tapping, maze learning and reaction-time tasks [19].

The median duration of residency was 5 years, which is, therefore, representative of Polish ophthalmologists shortly before or after receiving their specialist certification. It should be noted that a new 4-year specialisation program in ophthalmology was launched in Poland in the spring of 2023 [20], but it does not apply to the participants in this survey.

It was deemed satisfactory that the geographical representation reflected the distribution of the population across the most populated voivodeships. Participants reporting Masovia (voivodeship of Warsaw) as their voivodeship of origin made up the largest contingent, as expected. It should be noted, however, that the number of respondents must also be interpreted in light of the response rate relative to the size of the local medical population. Therefore, Silesia's voivodeship can be considered underrepresented in the survey, as we received only seven responses from their region, despite a medical density of 35.6 doctors per 10,000 inhabitants, comparable to Lesser Silesia (36.4) [21].

It should be emphasised that cataract surgery is not required in Poland's ophthalmology specialisation program. Regardless of program requirements, some training centres in Poland teach residents how to perform cataract surgery, but the frequency of this practice is difficult to estimate. This could have significantly influenced the study's results and willingness to participate because some groups may have never learned to perform cataract surgery. Logically and similarly to Germany, Polish residents reported having performed significantly fewer partially and fully completed cataract surgeries. Based on a study evaluating the impact of the pandemic, 92.8% of ophthalmic centres in Poland had suspended all elective ophthalmic surgeries between 2020 and 2021, including minor ophthalmic procedures, cross-linking, and laser procedures [22]. This is a significantly higher percentage than the other European countries, which could have contributed to the residents reporting lower numbers of cataract surgeries.

In Poland, the number of CS per 100,000 inhabitants (528.4) is lower than in comparable European countries, like Germany (1136.74), France (1416.59) or Spain (853.60). However, the number of cataract surgeons per million population (39.3) is similar to France (34.5) versus 11.3 in Germany). This positions Poland in an intermediary group [3, 23]. Because of the model of post-residency training in cataract surgery, it is to be expected that an increase in the number of cataract operations would bring Poland into the group "high volume surgeon".

In the Polish cohort, a generally lower level of self-confidence was found compared to the European cohort. This aligns with the strong correlation between the

number of CS performed and the confidence level. The potential of simulation-based medical education (SBME) is well-documented in the literature and could serve as a key component of surgical training to help address this concern. This is defined in the operational preparation phase by simulating real conditions of medical practice, which increases learning opportunities and integrates centralised feedback into the learning process. The learning characteristics identified included providing feedback, repetitive practice, curriculum integrations, range of difficulty levels, multiple learning strategies, capture of clinical variation, individual learning, and the ability to define outcomes or benchmarks [24]. The positive effect and recognised effectiveness of SBME has been demonstrated in several studies [25–27]. Indeed, before attempting live surgery, virtual reality (VR) simulators or live animal teaching models afford opportunities for training surgeons to practice with surgical instruments and learn fundamental technical skills. The development and implementation of training curricula utilising VR simulators could shorten the learning curve of training surgeons. After this period of "pre-training," learners could be exposed to technical procedures in clinical situations, following validated models for teaching psychomotor skills [24]. The tools most commonly used were wet labs (animal eyes) in Poland, with noticeably less use of virtual reality simulators (VRS) than the other big cohorts. The lesser use of VRS can be explained by the fact that, at the time of the survey, fewer than five simulators were available in Poland. Interestingly, women took part significantly more often in SBME training sessions than men.

It is noteworthy that the Polish cohort observed that ambidextrous individuals tend to perform more CS on average. This may potentially represent a statistically distorted result based on a single participant who reported a significantly higher number of CS than the rest of the cohort.

When looking at the most frequently learned surgical steps, there is consistency with the European cohort and already published data. Surgery is mainly learned in stages, and the earliest skills learned include the beginning (corneal incision, viscoelastic devices injection) and the end (IOL implantation). At the beginning and end of training, specific steps are perceived as difficult and comparable with the European cohort and previously published data [7, 28]. These include the procedures of capsulorhexis and cracking, in particular. It is noteworthy that the capsulorhexis is predominant, which can be attributed to the fact that most training focuses on the capsulorhexis technique, with comparatively less emphasis on cracking.

It should be noted that our study has several limitations. Some voivodeships are not represented, and others

have such small numbers of respondents that interpretation of the results is questionable. The survey is cross-sectional, retrospective and self-reported, leaving much room for subjectivity and the potential biases typical of this mode of data collection, such as recall bias, social desirability bias, information bias, confirmation bias and even non-response bias [29]. When asked about the number of cataract surgeries performed at the end of residency (question 15–16, see Appendix 1), there was no option to indicate zero procedures. It should also be pointed out that defining what was expected by partial surgery would have enabled a more refined interpretation of the results, leaving less room for subjectivity on the part of respondents. The absence of a question on the type of training setting or the willingness to learn surgery, which would have enabled a more reliable interpretation of the results, can also be pointed out.

Training in technical procedures often needs to be more systematic and structured [30]. Currently, educational research recommends a framework aligned with a competency-based educational paradigm. Indeed, this framework often incorporates specific attributes recommended for completion during training integrated into residency learning programs. A homogenised framework could scaffold teachers and students in the teaching, learning, and assessing of surgical competencies [31]. The Polish surgical program is based on a checklist of skills, which is not conducive to developing competency milestones [32]. It may be beneficial to consider dividing the four-year residency period into distinct stages, each aligned with a specific aspect of competence progression. The novice to expert performance skill acquisition continuum should be used as a construct reference. Indeed, the use of a methodologic framework for skill acquisition, adapted from the educational psychology literature, has resulted in higher levels of reliability and improved validity in the assessment process [11].

Furthermore, surgical competence could be defined as six development competencies with the development of competency milestones, including technical and non-technical skills such as patient care, medical knowledge, practice-based learning, interpersonal and communication skills, and systems-based practice [33]. Teaching technical skills such as cataract surgery should be based on active learning methods, including discovery learning, guided learning, demonstration learning and reflexivity learning. Developing comprehensive content knowledge and proficiency in diverse pedagogical approaches to teaching and assessment, complemented by understanding peer role models, was a key element of initial growth. The learning tools were characterised by the prioritisation of content, clarity of presentation, and adapting material to the learner's specific needs [34]. These methods should be employed in conjunction with, rather than

as a substitute for, more passive learning techniques such as repetition. According to the present authors, learning the learner and training the teacher to improve cataract surgery training could be interesting.

Conclusion

We collated reported data on cataract surgery training from a sample of Polish ophthalmologists in the EBO cohort. The data highlight the relatively low number of cataract operations performed by the respondents, resulting in lower confidence levels. This is consistent with the fact that, in Poland, surgical training takes place mainly after residency. Implementing training programs using VR simulators could help shorten the learning curve and increase confidence, especially as the number of cataracts requiring surgical cure is set to increase dramatically in the coming decades.

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Author contributions

R.Y. contributed to the analysis and interpretation of data, wrote the main manuscript text and prepared Tables 1, 2 and 3. M.M. contributed to the analysis and interpretation of data and revised the manuscript. L.S. participated in the conception of the manuscript and revised it. E.K. contributed to the analysis and interpretation of data and revised the manuscript. E.B. participated in the conception of the manuscript and revised it. S.N.D. contributed to design the study and participated in the acquisition of data. M.S. contributed to design the study and participated in the acquisition of data. F.L. contributed to design the study and participated in the acquisition of data. W.A. contributed to design the study and participated in the acquisition of data. R.A. contributed to design the study and participated in the acquisition of data. H.A. contributed to design the study and participated in the acquisition of data. C.C.G. contributed to design the study and participated in the acquisition of data. D.C. contributed to design the study and participated in the acquisition of data. B.C. contributed to design the study and participated in the acquisition of data. L.F. participated in the acquisition of data. T.K. contributed to design the study and participated in the acquisition of data. A.M. contributed to design the study and participated in the acquisition of data. R.M.C. contributed to design the study and participated in the acquisition of data. H.P.F. contributed to design the study and participated in the acquisition of data. B.S. participated in the acquisition of data. M.J.T. contributed to design the study and participated in the acquisition of data. R.I. contributed to design the study and participated in the acquisition of data. S.P. contributed to design the study and participated in the acquisition of data. J.S. contributed to design the study and participated in the acquisition of data. M.S. contributed to design the study, participated in the acquisition of data, contributed to the analysis and interpretation of data and revised the manuscript. T.B. designed the study, participated in the acquisition and interpretation of data and revised the manuscript.

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Data availability

The datasets used and analysed during the study reported herein are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by the ethics committee of the French Society of Ophthalmology (IRB 00008855 Société Française d'Ophtalmologie IRB#1). The survey informed all participants about the study's purpose, their right to withdraw at any time, and that their data would be collected, anonymised, aggregated and analysed to be part of a publication. Informed consent to participate was obtained from all of the participants in the study. The authors confirm that the study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments. The results of the European data collection have already been published.

Consent for publication

not applicable.

Competing interests

The authors declare no competing interests.

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