ANALYSIS OF THE BIOMETRIC DATA FOR THE INTRA-OCULAR LENS (IOL) POWER CALCULATION: A COMPARISON BETWEEN THE HUNGARIAN, KOSOVAN, AND BRAZILIAN POPULATIONS

Ph.D. thesis

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1. Introduction

1.1 Cataract

Cataract is an ocular disorder characterized by the clouding or opacification of the crystalline lens. Cataract is one of the leading causes of visual impairment and blindness worldwide [4-6]. Based on the etiology, cataract can be congenital or acquired. The most common type of acquired cataract is the age-related cataract.

1.2 Biometric parameters of the eye

The primary biometric parameters of the eye considered for IOL power calculation include: axial length (AL), anterior chamber depth (ACD), lens thickness (LT), central corneal thickness (CCT), corneal refractive power (K1, K2), white-to-white distance, pupil diameter, effective lens positioning (ELP) and vitreous chamber depth (VCD) [22-25].

The axial length (AL) is defined as the distance between the anterior surface of the cornea to the retinal pigment epithelium (RPE). In emmetropic adult eyes, the average axial length is 23.50 mm [26-30], whereas a newborn's eye has an AL of 16 mm (mm), and it increases to up to 24–25 mm [31,32]. The anterior chamber depth (ACD) is the distance between the anterior surface of the cornea and the anterior surface of the lens. The anterior chamber depth (ACD) is an important parameter in intraocular lens (IOL) power formulas to predict the appropriate IOL power.

IOL Power Calculation Formulas

Postoperative refractive results are the most important outcomes after cataract surgery. To meet patient expectations, several factors should be taken into consideration. It is estimated that the inaccuracy in AL measurements contributes to 36% of the error in the calculation of the IOL power and ELP estimation. Intraocular lens power calculation formulas are the subject of ongoing research, in efforts to obtain the most precise postoperative refractive results, IOL power calculation formulas are divided into 5 generations of formulas: *1st generation formulas* –

regression formulas; 2nd generation formulas – improved regression formulas; 3rd generation formulas – theoretical/optical formulas; 4th generation formulas – multivariable theoretical formulas; 5th generation formulas – artificial intelligence-based formulas.

Precise preoperative IOL planning depends on the axial length (AL), corneal power (K), and anterior chamber depth (ACD); a refractive error up to 3 diopter (D) could result after a 1 mm error in the AL measurment, and a 1 D error in the corneal power alters the IOL power for 1 D. Artificial intelligence (AI) has played a major role in the diagnosis, management, and treatment of cataracts, especially in biometry and IOL power calculation formulas. 5th-generation, AI-generated IOL power calculation formulas have proven to be very promising in predicting postoperative refraction.

1. OBJECTIVES

I. Main objective

The main objective of this study was to analyze and compare the biometric data for IOL power calculation between three populations: Hungarian, Kosovan, and Brazilian. Biometric data and biometric evaluation play a crucial role in accurate IOL selection and IOL power calculation.

Being that the differences in biometric data are significant between different populations, evaluating these parameters and comparing them between our study populations would yield very important scientific results, which would contribute to the improvement of clinical practice in IOL planning and selection and in the improvement of postoperative results.

II. Other objectives

1. To compare the axial length (AL) between the Hungarian, Kosovan, and Brazilian patients.
2. To compare the anterior chamber depth (ACD) between the Hungarian, Kosovan, and Brazilian patients.
3. To evaluate and compare the refractive outcomes after cataract surgery based on the IOL selection.
4. To evaluate and compare the refractive outcomes after cataract surgery based on the pre-operative visual acuity.
5. To present the impact of the surgeon's experience on the postoperative outcomes.

2. MATERIALS AND METHODS

This study was a cross-sectional observational multicenter study that included the biometric data of patients with cataract, scheduled to undergo cataract surgery with phacoemulsification and Intraocular Lens (IOL) implantation at three different centers, in three countries:1) the Ophthalmology Department of Semmelweis University, Budapest, Hungary, 2) the Ophthalmology Department of the University Clinical Center of Kosovo, Prishtina, Kosovo, and 3) the Department of Ophthalmology of the Faculty of Medicine of Ribeirão Preto, Sao Paulo, Brazil. This was a single-surgeon study per center, where all the patients were surgically treated and followed up by the same surgeon in each center.

3.1 Patient selection

In this study, we included 2047 eyes of patients with cataract who were scheduled to undergo cataract surgery with phacoemulsification and IOL implantation. Out of 2046 eyes included in this study, 1001 were of Hungarian patients, 416 were of Kosovan patients, and 630 were of Brazilian patients.

3.2 Data collection

All the data were collected from the Patient Data Management System in each center.

Biometric data were collected using the biometry measurements performed using the Haag-Streit LenStar 900 (Haag-Streit, Köniz, Switzerland) biometer. All biometric measurements were completed before the surgery. To comply with the protocol for maximal accuracy in measurements, a standard deviation (SD) value was set as a standard value, above which the data were not taken into consideration. Patients with a standard deviation (SD) higher than SD > 0.2 mm for the AL and SD > 0.13 mm for the ACD were not included in this study.

Preoperatively, the following biometric parameters were measured: axial length (AL), anterior chamber depth (ACD), corneal refractive power (K), lens thickness, and white-to-white distance

(WTW). Based on the measurement of these biometric parameters, IOL power was automatically calculated for each patient.

Each patient went through a preoperative ophthalmic examination, which included the assessment of the uncorrected visual acuity, best-corrected visual acuity, and tonometry – the measurement of intraocular pressure.

All the data of eligible patients were collected and inserted into a separate database for analysis by the same person appointed in each center as a part of this study group. We collected the biometry measurements of patients assigned to undergo cataract surgery with the standard procedure of phacoemulsification by the same surgeon, in each center, with 10 years of experience or more in cataract surgery using this method in each center.

Phacoemulsification, as a standard type of procedure for cataract surgery, was performed under local anesthesia, which was either subconjunctival or retrobulbar, based on the surgeon's choice.

Patient follow-up

To evaluate the postoperative outcomes, the subjects were followed up in three different periods: 1 week post-operatively, 2 weeks post-operatively, and 1 month post-operatively. Post-operatively, we evaluated the uncorrected and corrected visual acuity.

3.3 Statistical analysis

STATA 18 and SPSS 27.0 were used for the statistical analysis and graphic presentation of the collected data results. Descriptive statistics were used to summarize the central tendencies and variability. To analyze the correlation between the variables, we used Pearson's index of correlation, whereas to measure the impact of the independent variables on the dependent variable, we used multiple linear regression analysis. For the assessment of the group differences, we used a one-way ANOVA Multiple and a Post Hoc Tukey HSD test. ANOVA analysis is a statistical method used to compare the means of many sets of data and assess whether there are any statistically significant differences between them.

3. RESULTS

4.1 Descriptive statistics of the sample of the study

The total sample size was 2047 subjects from the three countries included in the study: Hungary, Kosovo, and Brazil. The highest number of patients is from Hungary, where 1001 patients, or 48.9% of the sample, belonged to this group. The second largest group of participants is from Brazil, with 630 patients or 30.78% and the lowest number of participants was from Kosovo with 416 patients or 20.32%.

4.2 Results of Hungarian Patients

In this study, we included a total of 1001 patients with cataract who underwent cataract surgery with phacoemulsification and Intraocular Lens (IOL) implantation at the Ophthalmology Department of Semmelweis University. The mean axial length in Hungarian patients was 23.60 mm ± 1.84, and the mean anterior chamber depth was 3.14 mm ± 0.45.

Table 1. Correlation between the age, axial length, and anterior chamber depth in Hungarian patients

		Age	**AL**	**ACD**
Age	Correlation	1	-.116**	-.250**
	Sig.		.000	.000
	N	993	990	900
AL	Correlation	-.116**	1	.351**
	Sig.	.000		.000
	N	990	998	908
ACD	Correlation	-.250**	.351**	1
	Sig.	.000	.000	

	N	900	908	908

Note: **. Correlation is significant at the 0.01 level (1%)

The results of our study show that age has an impact on the axial length and the anterior chamber depth. The correlation between age and axial length, and the correlation between age and anterior chamber depth are presented in Table 1. Our results show that there is a negative correlation between age and both parameters, the AL (r= -0.11) and the ACD (r= -0.25). The correlation between age, axial length, and the anterior chamber depth is statistically significant at the level of significance 1% (P=0.000). According to our findings, the axial length and the anterior chamber depth are lower in older patients.

To analyze the postoperative results, we have analyzed and compared the preoperative uncorrected distance visual acuity (UCDVA) and the best corrected distance visual acuity (BCDVA), with the 1-month postoperative uncorrected distance visual acuity (1 m. postop. UCDVA) and best corrected distance visual acuity (1 m. postop. BCDVA). The preoperative uncorrected distance visual acuity in Hungarian patients was 24.7% or 0.25 in decimal units for visual acuity, whereas the preoperative best-corrected distance acuity was 54.4% or 0.5. Our results show there was a significant improvement in visual acuity after cataract surgery. The 1-month postoperative uncorrected distance visual acuity in Hungarian patients was 77.9%, and the 1-month best-corrected distance visual acuity was 85.2% or 0.85.

14 different models of intraocular lenses were used to treat the Hungarian patients included in this study. The IOL model plays a very important role in the postoperative results; therefore, using the regression analysis, we assessed the impact of the IOL model and the preoperative visual acuity on the postoperative uncorrected visual acuity and best-corrected visual acuity. Based on the preoperative visual acuity, we divided our patients into three main groups: Group 1 - 0–33% (hand movement—0.33 preoperative visual acuity); Group 2—34–66% (0.34–0.66 preoperative visual acuity); Group 3—67–100% (0.67–1.0 preoperative visual acuity).
In Table 2, we have presented the results of the regression analysis on the impact of the IOL model and the preoperative visual acuity on the postoperative refractive outcomes.

Table 2. Intraocular lens (IOL) model and postoperative visual acuity.

Lens Type	UDVA 1 m postop.	BCDVA 1 m postop.	UDVA 1 m postop.	BCDVA 1 m postop.	UDVA 1 m postop.	BCDVA 1 m postop.	UDVA 1 m postop.	BCDVA 1 m postop.
	0–33		34–66		67–100		Total	Total
SN6AT	0.034 ** (2.67)	0.032 (1.14)	0.043 ** (2.12)	0.03 ** (2.22)	0.008 *** (4.53)	0.002 ** (1.99)	0.16 ** (2.14)	0.014 ** (2.85)
MX60	0.0428 (1.38)	0.0168 (0.58)	0.136 (1.38)	0.0521 (0.51)	0.115 (1.97)	0.0594 (1.03)	0.0411 (1.81)	0.0245 (1.19)
MA60AC	−0.177 *** (−4.41)	−0.0924 * (−2.44)	−0.177 (−1.77)	−0.0255 (−0.25)	−0.223 ** (−3.24)	−0.08 (−1.20)	−0.169 *** (−5.44)	−0.0852 ** (−3.04)
SN60WF	−0.0564 (−0.88)	−0.0736 (−1.24)	0.323 (1.62)	0.233 (1.1)	0.133 (1.4)	0.111 (1.18)	−0.073 (−1.51)	−0.0658 (−1.51)
PODFGF PHYSIOL	0.164 ** (3.24)	0.117 * (2.44)	0.323* (2.33)	0.233 (1.6)	0.175 * (2.49)	0.121 (1.71)	0.133 *** (3.91)	0.0914 ** (2.93)
JOHNSON JOHNSON TECNIS EYEHANCE ICB 00	−0.0184 (−0.06)	0.188 (0.67)	0.323 (1.62)	0.233 (1.1)	0.204 (1.26)	0.14 (0.86)	0.145 (1.1)	0.146 (1.21)
MA60MA	−0.335 ** (−2.74)	−0.345 ** (−2.97)					−0.397 *** (−3.69)	−0.388 *** (−3.94)
677MTY	0.219 ** (2.83)	0.182 * (2.47)	0.256 (1.97)	0.217 (1.59)	0.16 (1.85)	0.129 (1.5)	0.179 *** (3.62)	0.139 ** (3.09)
VERI SYSTEM AMO	−0.0184 (−0.06)							
LUX SMART	0.0482 (0.28)	−0.0454 (−0.28)	0.223 (1.12)	0.233 (1.1)	0.144 (1.33)	0.12 (1.11)	0.184 * (2.56)	0.139 * (2.11)
VIVITY	0.182 (1.22)	0.088 (0.62)					0.12 (0.91)	0.0457 (0.38)
VIVINEX	−0.0851 (−0.84)	−0.0787 (−0.82)	−0.527 (−1.93)	−0.167 (−0.78)	−0.646 ** (−2.88)	−0.26 (−1.60)	−0.0442 (−0.69)	−0.0385 (−0.68)
621P ZEISS		−0.312 (−1.92)					−0.28 (−1.85)	−0.354 * (−2.56)
SA60AT	−0.218 (−1.28)						−0.18 (−0.69)	−0.254 (−1.07)
Cons	0.718 *** (28.27)	0.812 *** (34.14)	0.677 *** (9.28)	0.767 *** (10.5)	0.796 *** (17.4)	0.860 *** (19.42)	0.780 *** (42.55)	0.854 *** (51.8)
N	612	619	62	67	118	122	883	895

Our results showed that AcrySof IQ toric SN6AT (Alcon, Fort Worth, TX, USA) IOL, which was used implanted in 22.28% of the cases, had a statistically significant positive impact in all groups ($p < 0.05$), with the highest positive impact (B = 0.043) on the 1-month postoperative visual acuity of the second group of patients (0.34–0.6 preoperative visual acuity). However, in all three groups of patients, AcrySof IQ toric SN6AT IOL had a statistically significant positive impact on the postoperative outcomes ($p < 0.05$); 1-month uncorrected postoperative visual acuity had a positive coefficient of B = 0.16, while the 1-month best corrected postoperative visual acuity had a positive coefficient of B = 0.14. Another IOL model with a significant positive impact on postoperative visual acuity was found to be the FINEVISION HP (POD F GF) IOL (BVI, Waltham, MA, USA),

similar to the AcrySof IQ toric SN6AT IOL. The highest positive impact was found in the second group of patients (B = 0.323). In terms of the total impact on the three groups, the FINEVISION HP (POD F GF) IOL was found to have a positive impact (B = 0.133) on uncorrected 1-month postoperative distance visual acuity, and an impact of B = 0.0914 in the 1-month best-corrected distance visual acuity, which was also statistically significant ($p < 0.05$).
The IOL used for most patients (43.36%), enVista MX-60 (Bausch & Lomb, Bridgewater, NJ, USA), exhibited an overall positive impact on the visual acuity in all patients; however, it was not statistically significant.

4.3 Results of Kosovan Patients

A total of 416 patients with cataract were treated surgically with phacoemulsification and IOL implantation at the Ophthalmology Department of the University Clinical Center of Kosovo.

The mean age of Kosovan patients was 70.4 years. In terms of biometric data, the mean axial length was AL 23.23 mm, and the anterior chamber depth was ACD 3.12 mm.

Table 3 presents the results of the correlation between the age, the axial length and the anterior chamber in Kosovan patients. Based on the correlation analysis, similar to the Hungarian patients, there is a negative correlation between age and the axial length and the anterior chamber, also in the Kosovan patients included in the study. The correlation between age and axial length was r = -0.04; however, it was not statistically significant (P = 0.330). On the other hand, there was a statistically significant negative correlation at the 1% level between age and anterior chamber depth, r = -0.18, and P = 0.000.

Table 3. Correlation between the age, axial length, and anterior chamber depth in Kosovan patients

		Age	**AL**	**ACD**
	Correlation	1	-.048	-.188**
Age	Sig.		.330	.000
	N	416	415	392
AL	Correlation	-.048	1	.289**

	Sig.	.330		.000
	N	415	415	392
ACD	Correlation	-.188**	.289**	1
	Sig.	.000	.000	
	N	392	392	392

The mean preoperative distance visual acuity in these patients was 15% or 0.15 in decimal units, whereas the mean uncorrected 1-month postoperative distance visual acuity increased to 44% or 0.4 in decimal units, and the best-corrected distance visual acuity increased to 49.6% or 0.5 in decimal units.

The Kosovan patients were treated with one of the two monofocal IOL types, AcrySof SA60AT IOL (Alcon, Fort Worth, TX, USA) and Akreos ADAPT AO (Bausch & Lomb, Bridgewater, NJ, USA), available at the study center. Akreos ADAPT AO was used in 64.18% of the patients and AcrySof SA60AT was used in 35.82% of cases.

Using the regression analysis, we have assessed the impact of the IOL model on the postoperative outcomes of the patients. Based on the preoperative visual acuity, we divided our patients into three main groups: Group 1 - 0–33% (hand movement—0.33 preoperative visual acuity); Group 2—34–66% (0.34–0.66 preoperative visual acuity); Group 3—67–100% (0.67–1.0 preoperative visual acuity. The AcrySof SA60AT IOL was used in 35.82% of the patients and was found to have an overall positive impact on postoperative distance visual acuity in all three groups. However, there was a higher positive impact on the postoperative distance visual acuity of patients in the second group, who had a preoperative UDVA from 0.34 to 0.66 (B = 0.321), which was statistically significant. The other IOL model, Akreos ADAPT AO, was used in 64.18% of cases, and it was found to have an overall positive impact on postoperative visual outcomes in all groups. Similar to AcrySof SA60AT, Akreos ADAPT AO also resulted in a higher positive impact (B = 0.408) on the patients, whose preoperative distance visual acuity was between 34 and 66%, which was statistically significant at the 5% level. Even though, both IOL models had a statistically significant positive impact on postoperative distance visual acuity, Akreos ADAPT AO was considered to have a higher positive impact (B = 0.408) than AcrySof SA60AT. (Table 4)

Table 4. Intra-Ocular Lens (IOL) model and postoperative distance visual acuity

Lens Type	**UDVA 1-Month Postop.**	**UDVA 1-Month Postop.**	**UDVA 1-Month Postop.**	**UDVA 1-Month Postop.**
	0–33	**34–66**	**67–100**	**Total**
AcrySof SA60AT	0.0152 (1.78)	0.321 * (1.81)	0.101 (0.53)	0.0242 (1.14)
Akreos ADAPT AO	0.0262 (1.30)	0.408 ** (2.20)	0.11 (0.62)	0.0309 (1.37)
Cons	0.415 *** −25.74	0.575 ** −4.74	0.743 *** −5.58	0.459 *** −25.57
N	344	7	16	397

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.4 Results of Brazilian Patients

630 Brazilian patients with cataract were included in our study; they were surgically treated with phacoemulsification and IOL implantation in the Ophthalmology Department of the Faculty of Medicine of Ribeirão Preto, São Paulo in Brazil. 30.78% of our study sample was composed of Brazilian patients. The mean axial length in Brazilian patients was 23.3mm, compared to Hungary and Kosovo there is no big difference in the mean axial length; however, the mean anterior chamber depth was higher, ACD= 3.15 mm, compared to Kosovo and Hungary.

A total of 4 different IOLs were implanted in the Brazilian patients. AcrySof IQ ReSTOR IOL SN6AD1 (Alcon, Fort Worth, TX, USA) multifocal IOL was the most used. AcrySof IQ ReSTOR IOL SN6AD1 was implanted in 31.43% of the cases, the second most used IOL, in 28.57% of the cases was the Alcon SN60WF single-piece. AcrySof IQ Vivity was the third most used IOL with 20.95%. The least used was the extended depth of focus (EDOF) IOL, Tecnis Symfony IOL (Johnson&Johnson, 7500 Centurion Parkway North, Jacksonville, Florida 32256 United States), in 19.05% of the cases. Through the regression analysis, we have assessed the impact of each IOL model on the postoperative results. Based on the results presented in Table 18, the AcrySof IQ Vivity was the lens with the highest positive impact on the postoperative visual acuity, with the coefficient B=0.065, which is statistically significant at the level of 1% ($p<0.01$). Tecnis Symfony has been shown to have a statistically significant positive impact at the level of 1% ($p<0.01$), in the postoperative visual acuity in the Brazilian patients. Also, the other IOLs, AcrySof IQ SN6AD1 and SN60WF had a positive impact on the postoperative results; however, it was not statistically significant (Table 5)

Table 5. Intraocular lens (IOL) model and postoperative visual acuity

BCVA	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
SN6AD1	0.021	0.012	1.75	0.567	0.006	0.027	
SN60WF	0.001	0.007	0.00	0.999	-0.014	0.014	
SYMFONY	0.031	0.008	-3.86	0.000	-0.047	-0.015	***
VIVITY	0.065	0.008	-8.46	0.000	-0.081	-0.05	***
Constant	1.01	0.005	205.52	0.000	0.99	1.01	***

Mean dependent var	0.981	SD dependent var	0.073
R-squared	0.630	Number of obs	624
F-test	30.747	Prob > F	0.000
Akaike crit. (AIC)	-1571.579	Bayesian crit. (BIC)	-1553.835

4.5 Comparison between countries – Hungary, Kosovo, and Brazil

. Of 2047 patients, 1001 were Hungarian patients treated in the Ophthalmology Department of Semmelweis University; 630 were Brazilian patients treated in the Ophthalmology Department of the Faculty of Medicine of Ribeirão Preto, São Paulo in Brazil, and 416 were Kosovan patients treated in the Ophthalmology Department of the University Clinical Center of Kosovo.

4.5.1 Comparison of the Axial Length and Anterior Chamber Depth between Hungary, Kosovo, and Brazil

Table 6. Axial Length and Anterior Chamber Depth

Variables	Kosovo		Hungary		Brazil	
	Mean	**Std Dev**	**Mean**	**Std Dev**	**Mean**	**Std Dev**
Age	70.4	9.23	68.97	12.35	-	-
AL	23.23	0.98	23.6	1.84	23.3	0.954
ACD	3.12	0.42	3.14	0.45	3.152	0.417

Table 6 presents the mean axial length and anterior chamber depth in each study group. The mean axial length in Kosovan patients is 23.23 mm ± 0.98, and a similar axial length was found in Brazilian patients (AL = 23.3 mm ± 0.954); however, the axial length in Hungarian patients differs (AL = 23.60 mm ± 1.84) compared to that of patients from Kosovo and Brazil. The mean anterior chamber depth (ACD) is the lowest in the Kosovan patients (3.12 mm ± 0.42) and the highest in the Brazilian patients (3.15 mm ± 0.417).

We used the one-way ANOVA for the statistically significant results; these results show that there are statistically significant differences in the axial length (AL) and anterior chamber depth (ACD) between the three groups of patients - from Hungary, Kosovo, and Brazil. Based on these results, we conclude that there is a statistically significant difference in the axial length (AL) between Hungarian patients and Kosovan and Brazilian patients, where $p = 0.000$, which is less than $p = 0.05$ (Table 7). On the other hand, there is no statistically significant difference in the axial length (AL) between the Kosovan and Brazilian subjects included in this study. The results for the other evaluated biometric parameter, the anterior chamber depth (ACD), show that there is no statistically significant difference between all three groups of patients, where the p-value is $p = 0.631$, which is greater than $p = 0.05$ (Table 7).

Table 7. One-way ANOVA—Hungary, Kosovo, and Brazil

		Sum of Squares	df	Mean Square	F	Sig.
AL	Between Groups	55.74	2	27.87	12.973	0.000
	Within Groups	4382.77	2040	2.14		
	Total	4438.51	2042			

	Between Groups	0.175	2	0.088		
ACD	Within Groups	366.404	1924	0.190	0.460	0.631
	Total	366.579	1926			

Table 24. Statistically significant differences in the postoperative outcomes based on the surgeon's experience.

UDVA preop.	**Posterior**			**95% Credible Interval**		**Significant Differences**
	Mode	**Mean**	**Variance**	**Lower Bound**	**Upper Bound**	
11 Years Experience	0.150	0.150	0.000	0.121	0.180	P=0.000
24 Years Experience	0.247	0.247	0.000	0.227	0.266	
UDVA 1-month postop.	**Posterior**			**95% Credible Interval**		**Significant Differences**
	Mode	**Mean**	**Variance**	**Lower Bound**	**Upper Bound**	
11 Years Experience	0.440	0.440	0.000	0.414	0.467	P=0.000
24 Years Experience	0.779	0.779	0.000	0.762	0.796	
BCDVA 1-month postop	**Posterior**			**95% Credible Interval**		**Significant Differences**
	Mode	**Mean**	**Variance**	**Lower Bound**	**Upper Bound**	
11 Years Experience	0.496	0.496	0.000	0.472	0.521	P=0.000
24 Years Experience	0.852	0.852	0.000	0.836	0.868	

There was a statistically significant difference in the postoperative results based on the surgeon's experience. The preoperative UDVA in the Kosovan patients, where the surgeon had 11 years of experience in phacoemulsification, was 0.15 or 15%, whereas the UDVA in the Hungarian patients before the surgery was 0.25. Based on Table 24, there were statistically significant differences in the 1-month postoperative outcomes between the two groups, according to the particular surgeon. Based on the *p-value*, where $p = 0.000$, there was a statistically significant difference in the postoperative outcomes based on the surgeon's experience in phacoemulsification.

Table 25 presents the statistically significant difference on the 1-month postoperative best corrected distance visual acuity. Statistically significant differences between the three groups of patients were found for the 1-month BCDVA. The BCDVA in the Hungarian patients was 85.2%, in the Kosovan patients, it was 49.6% whereas in the Brazilian patients it was 98.1%. Based on the one-way ANOVA results with F-statistic of 859.57 and $p = 0.001$, we can conclude that there is a statistically significant difference in the 1-month postoperative distance visual acuity between the patients from all three countries.

Table 25. One-way ANOVA on the 1-month postoperative distance visual acuity

Country	**BCVA**	**Mode**	**Mean**	**df**	**F**	**Sig.**
Hungary	Between Groups	0.852	0.852	2		
Kosovo	Within Groups	0.440	0.440	1966	859.57	0.000
Brazil	Total	0.981	0.981	1968		

5. Conclusions

To achieve better postoperative results, it is crucial to have a detailed and precise preoperative assessment, with a great emphasis on the measurement of the biometric parameters and IOL power calculation. The biometric parameters of the eye differ between different populations, ethnicities, and races. Our project aimed to analyze and compare the biometric data of three groups of patients from: Hungary, Kosovo, and Brazil, and to predict possible factors that play a role in the differences between these groups, which have different demographic and socio-economic features. Through the literature search, we have come across many studies conducted in many countries and populations; however, our study is the first one to compare these three populations. We have also assessed the impact of the IOL model on the postoperative results, based on the preoperative visual acuity of the patients. This factor, together with the specific study populations, highlight the novelty of our research.

In regard to biometric parameters, we have analyzed the most important parameters such as: the axial length, anterior chamber depth, corneal power, and lens thickness. There was a statistically significant difference in the axial length and anterior chamber depth between the groups of patients.

The availability of premium IOLs is a key factor to obtain satisfactory postoperative outcomes, based on our results we can conclude that premium IOLs produce better postoperative outcomes. Our study supports this conclusion based on the statistically significant differences in the 1-month postoperative distance visual acuity between Hungary, Kosovo, and Brazil. The 1-month postoperative visual acuity was significantly higher in the Hungarian and Brazilian subjects, compared to the Kosovan subjects. This difference can be attributed to the unavailability of premium IOLs for the Kosovan patients. Nevertheless, the operating surgeons did not come from the same experience; therefore, there was also a statistically significant difference in the postoperative refractive outcomes between Hungarian and Kosovan patients, based on the surgeon's experience, where Hungarian patients had better distance visual acuity, taking into consideration the longer experience of the operating surgeon. In general, our findings show the importance of the IOL model in refractive outcomes following cataract surgery. The postoperative outcomes were more than 35% higher in the Hungarian and more than 48% in the Brazilian patients than in the Kosovan ones.

6. Novelty and new findings

- It is the first study comparing the biometric parameters between the Hungarian, Kosovan, and Brazilian populations.
- There were statistically significant differences in the axial length (AL) and anterior chamber depth (ACD) between the three populations.
- There was a statistically significant negative correlation ($r = -0.096$) at the 1% ($p = 0.003$) level of significance between lens thickness and distance visual acuity after surgery
- This is one of the first studies that analyzed the impact of the IOL model on the postoperative outcomes, based on the preoperative distance visual acuity.

7. Bibliography

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