



RESEARCH ARTICLE

REVISED Prevalence of anisometropia in children and adolescents [version 4; peer review: 2 approved]

Previously titled: 'Frequency of anisometropia in children and adolescents'

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<https://doi.org/10.12688/f1000research.73657.4>**Abstract****Background:** This research was developed to study the epidemiology of anisometropia. It aims to estimate the prevalence of anisometropia in Portuguese children and adolescents at various educational stages, studying its association with sociodemographic variables.**Methods:** Observational cross sectional study involving 749 children and adolescents (from 3 to 16 years old) from the central region of Portugal. The refraction was performed with a paediatric, open field auto refractometer (PlusOptix), without cycloplegia and under binocular conditions, to determine the rate of anisometropia and its association with gender, study cycle and area of residence.**Results:** The prevalence of anisometropia in the studied sample was 6.1%, varying from 2.9% in pre-school education to 9.4% in the 3rd study cycle. Myopic anisometropia was the most prevalent and hyperopic and astigmatic anisometropia showed identical proportions of occurrence. No statistical differences were found between genders or between areas of residence regarding the rate of anisometropia. Regarding spherical equivalent anisometropia, there was a pattern of variation that increased with the cycle of studies ($p = 0.012$), with myopic anisometropia being the main contributor to this variation.**Conclusions:** This study found an increase in anisometropia with the educational stage. The high rate of anisometropia found in adolescents (9.4%) as well as the progressive increase in this rate throughout school progress (from 2.9% to 9.4%) suggests the need to extend the detection strategies of this condition beyond childhood.**Keywords**

Pediatrics, Child, Teenager, Refraction, School vision

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REVISED Amendments from Version 3

The new version includes minor changes:

- Correction of a spelling error and removal of a sentence in the methods section.
- Removal of a statistical data in the abstract and in the results section.

Any further responses from the reviewers can be found at the end of the article

Introduction

Anisometropia is an ocular disorder characterized by an interocular difference (IOD) in refractive error. It represents a specific refractive condition where the two eyes of an individual, can have asymmetric eye growth.¹ This condition can occur in situations of myopic, hyperopic or astigmatic asymmetry and is strongly associated with the development of other eye changes such as aniseikonia, amblyopia, diplopia and strabismus.^{2,3}

Although there is no uniformly defined dioptric value for its clinical classification, an IOD in the spherical equivalent (SE) of 1 diopter or more is accepted as the threshold, for most authors.^{1,4-8} However, even using this limit, the scientific literature presents a significant variation in the prevalence values of anisometropia in terms of age, gender and ethnicity.^{4,5,8,9} Factors associated with lifestyle and educational level have also been referred to as risk factors for anisometropia.^{7,8,10}

Early detection and early treatment is crucial to prevent permanent visual loss. Although it is not clear what is the ideal age to perform the correction, in order to guarantee an ideal visual development and maturation, the early correction of anisometropia is important.¹¹ This prevents the development of other changes such as aniseikonia, amblyopia and strabismus,^{3,12,13} and even in small degrees (<1D) facilitates emmetropization.¹¹ It also improves quality of life, reducing or eliminating symptoms of visual discomfort. In this way, visual screening at a young age is useful in identifying who is most likely to benefit from early optical correction or preventive treatment.^{11,14,15}

The clinical methods used to characterize anisometropia are refractive techniques, with autorefraction, using Plusoptix, one of the most recommended techniques for screening activities.^{16,17} This instrument allows quantifying the refractive error in which it is possible to obtain a very similar value to that obtained by cycloplegic refraction¹⁷⁻¹⁹ and with excellent precision in anisometropia signalling.¹⁹

Studies on the prevalence of anisometropia focus on children or adults, with less research being found in adolescence.

The aim is to estimate the prevalence of anisometropia (spherical and astigmatic) and to analyse its pattern of variation in a sample of children and adolescents, from preschool education (from three to six years old) to the various cycles of basic education (from the 1st to the 9th school year in Portugal, from six to fifteen years old).

Methods

This is an observational cross sectional study to evaluate the prevalence of anisometropia in children and adolescents. Data from the Portuguese Census 2011, showed a population of 319284 from 0 to 14 years old in the central region.²⁰ For a confidence level of 95% and a 5% margin of error, taking into account that the prevalence of the studied condition is unknown, it was fixed at 50% to obtain a large enough sample size. The result was a minimum of 384 subjects.

The data collection took place in five schools of the central region of Portugal, including all students that were authorized to participate by their legal guardians, between October 2018 and February 2019. Participants were 749 children and adolescents aged between three and sixteen years. Students data for which it was not possible to obtain refraction were excluded, due to technical issues associated with the performance of the instrument (presence of strabismus, opacities, retinal anomalies or when the refractive error exceeded the instrument's measurement limit - spherical measurement range or cylindrical from -7.00 to +5.00D) or due to lack of cooperation from the participant. Only two participants were excluded.

The refractive error was measured with the paediatric auto refractometer model A09 by PlusOptix, Nuremberg, Germany, by the average of three consecutive measurements, binocular and without the use of a cycloplegic. The PlusOptix allows measuring the refractive error in open field simultaneously in both eyes and under the same conditions, in a fast, easy, safe, non-invasive way, at a distance of one meter from the subject's eyes.

Sample characterization

In Portugal the compulsory education includes basic education, which is divided into 3 cycles, followed by the secondary education. The 1st cycle of basic education includes the 1st to 4th school year (ages 6 to 10), the 2nd cycle includes the 5th and 6th year (ages 10 to 12) and the 3rd cycle includes the 7th to the 9th year (ages 12 to 15). The sample under study had students from preschool to the 3rd cycle of basic education and was characterized according to gender, area of residence and cycle of studies. Rural and urban areas classification was based on the information provided by the municipalities, considering the residence area of each participant. Regarding the use of glasses, 177 participants wore glasses or contact lenses and 572 did not use any type of optical correction. **Table 1** summarizes the characteristics of the sample.

Data analysis

In order to calculate the average of the three refractive measurements, the power was converted from its spherical-cylindrical form to its power vector representation, described by Thibos,²¹ using the following expressions:

$$SE = S + \frac{C}{2} \quad (1)$$

$$J_0 = \left(-\frac{C}{2}\right) \cos(2\alpha) \quad (2)$$

$$J_{45} = \left(-\frac{C}{2}\right) \sin(2\alpha) \quad (3)$$

Where SE represents the spherical equivalent; J_0 represents Jackson's crossed cylinders on the 90° or 180° axis, which stands for the amount of direct or indirect astigmatism; J_{45} represents Jackson's crossed cylinders on the 45° or 135° axis, which stands for the amount of oblique astigmatism; S , C and α represent the spherical, cylindrical (in negative form) and cylinder axis component, respectively, of the auto refractometer measurement.

Refractive state classification

The participants were classified in emmetropes, myopes, hyperopes, astigmats or anisometropes, according to the average value of the auto refractometer. In order to carry out this classification, the criteria recommended for the auto refractometer used were applied (**Table 2**).

Anisometropia classification

The absolute value of IOD of the refractive error in terms of SE was designated as spherical anisometropia (SA), the absolute IOD in astigmatism was designated as meridional anisometropia (MA),

$$SA = |SE_{RE} - SE_{LE}| \quad (4)$$

$$MA = |C_{RE} - C_{LE}| \quad (5)$$

where RE refers to the right eye and LE to the left eye.

Table 1. Sample characteristics.

Factor		Sample dimension n (%)	Wearing glasses		
			Yes (n)	No (n)	missing
Gender	Male	399 (53.3%)	80	318	1
	Female	350 (46.7%)	95	254	1
Residence area	Rural	320 (42.7%)	69	249	2
	Urban	423 (56.5%)	104	319	0
	Missing	6 (0.8%)	-	-	-
Study stage	Preschool	103 (13.8%)	3	100	0
	1 st cycle	231 (30.8%)	36	195	0
	2 nd cycle	181 (24.2%)	44	136	1
	3 rd cycle	234 (31.2%)	92	141	1

Table 2. Classification criteria for refractive state.¹⁶

Refractive state	< 6 years old	≥6 years old
Emmetrope	$-1.00D < SE < +1.25D$	$-1.00D < SE < +1.00D$
Myope	$SE \leq -1.00D$	
Hyperope	$SE \geq +1.25D$	$SE \geq +1.00D$
Astigmat	$ C \geq 1.00D$	$ C \geq 1.25D$
Anisometrope	$ IOD \geq 1.25$ (SE or C)	

When there was no IOD in the spherical equivalent and the absolute IOD was only in the astigmatic component, it was designated by simple meridional anisometropia (sMA). The anisometropia classification was done according to the cutoff points referred to in Table 2. The presence of at least one of the previous conditions was designated as total anisometropia (TA). Low anisometropia was considered for IOD values below 2.00D, high anisometropia for values between 2.00D and 6.00D and very high anisometropia for IOD values above 6.00D.

According to the type of refractive error, anisometropia was classified as myopic, when both eyes were myopic or when one eye was myopic and the other was emmetropic; hyperopic, when both eyes were hyperopic or when one eye was hyperopic and the other emmetropic; antimetropic, when one eye was myopic and the other hyperopic; simple meridional anisometropia when there was no SA, but there was MA.

Statistical analysis

A descriptive statistical analysis was carried out, using SPSS version 26 package, characterizing the sample in the variables of interest, sociodemographic and refractive, presenting means and standard deviations, frequencies and percentages both in the whole of the sample and also according to several stratifications to which it was subjected.

In all the sociodemographic factors in which the sample was categorized, groups with a large size ($n > 30$) were obtained. The proportion of subjects with anisometropia was analysed according to gender, area of residence and school cycle, and through the Chi-square test, it was evaluated whether these variables were associated with the occurrence of anisometropia in the studied population.

All the results of the statistical inference tests were interpreted to a 95% confidence level, that is, the significance level of 0.05 was used.

Ethics approval

This study was conducted in accordance with the principles of the Declaration of HELSINKI and written informed consent as obtained from parents of each participant in the study. It was approved by the Ethics Committee from Universidade da Beira Interior (CE-UBI-Pj-2019-043).

Consent to participate

Written informed consent was obtained from parents or legal guardians of all participants.

Results

Refractive state

According to the classification criteria previously defined for the classification of refractive state, it was concluded that in the study sample 71.16% ($n = 533$) were emmetropic. Among subjects with significant refractive error ($n = 216$), it was found that hyperopia was the most prevalent refractive error ($n = 109$, corresponding to 14.6% in the studied population) followed by myopia ($n = 49$, corresponding to 6.5% in the population), anisometropia ($n = 46$, corresponding to 6.1% in the population) and astigmatism ($n = 25$ where 12 were cases of simple astigmatism and 13 compound astigmatism). Figure 1 shows graphically the distribution of the different refractive states in the study sample. The representation of astigmatism, refers only to the occurrence of simple astigmatism, without a significant SE. The mean values of refractive errors, according to the previous classification, are shown in Table 3.

Anisometropia

Anisometropia was identified in 46 participants (6.1% of the studied population). Regarding the use of glasses, it was observed that eight cases did not use any type of optical correction.

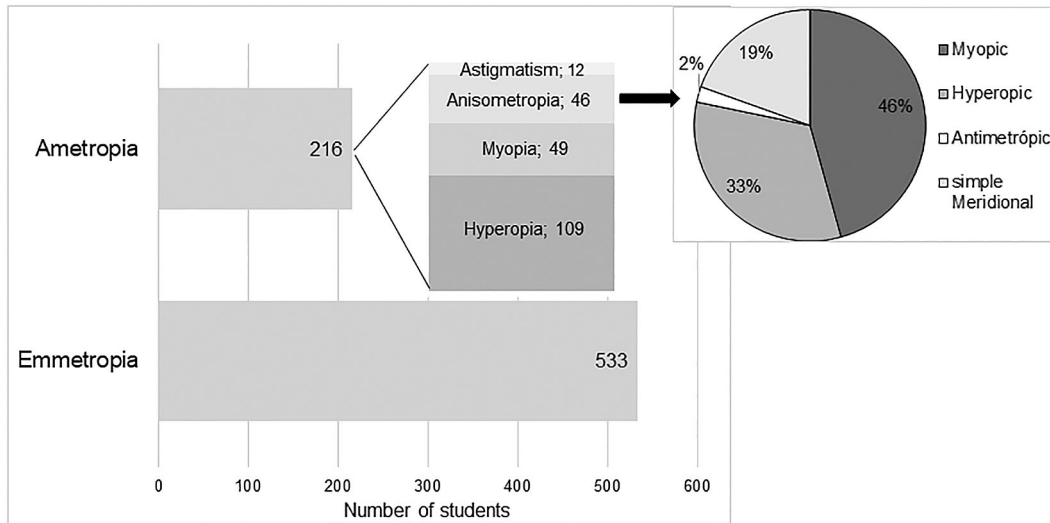


Figure 1. Refractive error distribution.

Table 3. Mean values and standard deviation of refractive errors of subjects with significant ametropia (right eye data).

Refractive group	Wearing glasses (n)		Spherical equivalent (D)		Cylindrical component (D)	
	Yes	No	Mean ± SD	Range [min; max]	Mean ± SD	Range [min; max]
Myopia	44	5	-2.67 ± 1.32	-5.79; -0.92	-0.39 ± 0.33	-1.29; 0.00
Hyperopia ^s	22	85	+1.46 ± 0.59	+1.00; +5.25	-0.41 ± 0.47	-2.50; 0.00
Simple astigmatism	6	6	+0.29 ± 0.55	-0.83; +1.21	-1.50 ± 0.33	-2.07; -1.14
Anisometropia ^f	37	8	Interocular difference			
			1.53 ± 0.82	0.00; 3.79	0.78 ± 0.85	0.00; 3.9

^sTwo cases without data regarding the use of glasses.

^fOne case without data regarding the use of glasses.

According to the magnitude of the refractive error, no child was found with very high anisometropia, 15 were registered with high anisometropia and 31 with low anisometropia, that is, of the anisometropia subjects, most (67.4%) had low anisometropia. The dispersion of interocular difference in SA and MA is shown in Table 3.

In the classification of anisometropia according to the type of refractive error, 37 subjects (corresponding to 4.9% in the studied population) were found with SA, integrating 21 with myopia, 15 with hyperopia and 1 with antimetropia; 15 subjects (corresponding to 2% in the population) with MA, and only 9 of these did not have SA, and were classified as simple meridional anisometropia (sMA). This distribution is represented graphically in Figure 1. It is possible to observe that myopic anisometropia was the most prevalent (46%), followed by hyperopic anisometropia (33%) and sMA (19%). Antimetropia anisometropia was the least prevalent (2%).

Influence of sociodemographic variables

The study of the influence of sociodemographic variables in the occurrence of anisometropia is presented in Table 4. The Chi-square test indicates that there was no association between MA and any of the factors under analysis.

No significantly different occurrence of anisometropia was found according to gender or area of residence (p > 0.05). In relation to the school, there was a pattern of variation that increased with the cycle of studies, ranging from 2.9% in preschool education to 9.4% in the 3rd cycle of studies, however this association was only statistically significant for SA

Table 4. Relationship of gender, area of residence and study cycle, in anisometropia.

	Gender								Chi-square test
	Female (350)				Male (399)				
	N	%	N	%	N	%	N	%	p
TA	25	7.1	21	5.3					0.29
SA	21	6	16	4					0.21
MA	8	2.3	7	1.8					0.60
	Area of residence								Chi-square test
	Rural (320)				Urban (423)				
	N	%	N	%	N	%	N	%	p
TA	22	6.8	23	5.4					0.42
MA	7	2.2	8	1.9					0.78
SA	18	5.6	18	4.3					0.39
	School stage								Chi-square test
	Preschool (103)		1 st cycle (231)		2 nd cycle (181)		3 rd cycle (234)		
	N	%	N	%	N	%	N	%	p
TA	3	2.9	10	4.3	11	6.1	22	9.4	0.06
MA	2	1.9	3	1.3	6	3.3	4	1.7	0.52
SA	1	1.0	9	3.9	7	3.9	20	8.6	0.012*
<i>p</i> _(adjust)	0.36		<0.001*		<0.001*		0.015*		

TA - Total anisometropes (spherical and meridional); SA - spherical equivalent anisometropia; MA - meridional anisometropia. The highest rates are shown in bold. Multiple comparisons with Chi-squared test for study cycles (Z: adjusted standardized residual to Chi-Square and *p* adjusted to Bonferroni correction).

*Significant at the 0.05 level.

(*p* = 0.012), where there was a rate of 1% in preschool education and 8.6% in the 3rd cycle. It should be noted that the study cycle is dependent on age.

Figure 2 illustrates the distribution of anisometropia according to the type of refractive error, for each school cycle. It is observed that myopic anisometropia was present in all study cycles, registering a considerable increase from the beginning of school, that is, from the 1st cycle to the 3rd cycle. On the other hand, hyperopic anisometropia was manifested on a larger scale in children of the 1st cycle, with a lower occurrence in the following cycles. As for the simple MA, it was present in all study cycles and there was no specific pattern in its variation with the study cycle progress.

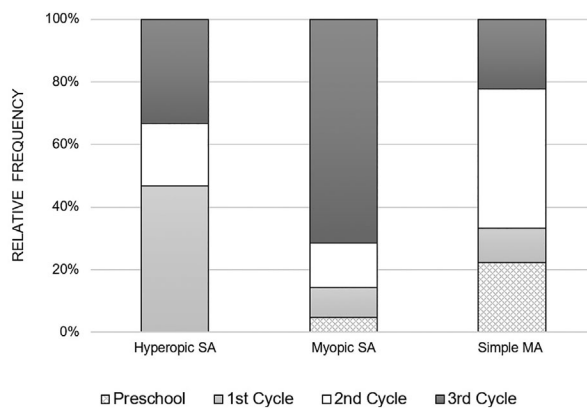


Figure 2. Relative frequency of the variation of the various types of anisometropia, with the school cycle.

Discussion

An anisometropia rate of 6.1% was found, considering the spherical and meridional anisometropia. It was found that this rate varies with the cycle of studies, showing an increase as the level of education advances, ranging from 2.9% in preschool education to 9.4% in the 3rd cycle of basic education. No statistically significant differences were found in the distribution of anisometropia either between genders or between areas of residence. It was also found that myopic anisometropia was the most prevalent (46%), with a considerable increase in the 3rd cycle of studies.

Table 5 summarises worldwide epidemiological data regarding studies in children and adolescents, which used the same criterion for anisometropia definition ($IOD \geq 1D$).

Comparing with others studies, some authors point to a frequency similar to the one found on this research,^{4,7,8,11,25} others point to a lower frequency²⁴ and others still refer to a higher frequency.^{22,23} Studies that included only children aged five and six years report rates of 1.3% and 1.6% (SA).^{5,26} The frequency of SA, found in the present study, in preschool education (children from three to six years old) was 1%, this value being closer to those studies. Other studies included participants from 15 to 19 years old and report rates of 11,2% for SA.²³ For the 3rd cycle of studies (average between 12 and 15 years of age), the present study indicated a frequency of 8.6% (SA) and according to the observed variation pattern, at a more advanced age and school stage, a higher rate is expected.

Geographical and methodological issues make it difficult to compare prevalence studies. There is a pattern of greater variability in studies on the Asian continent, where for an identical age group, there are records ranging from 2.5%²⁴ to more than 10%;⁷ however this is the continent where more studies on the subject are found. In Europe, more similar results are found, 4,6% and 6,9%.^{4,11} In Portugal, a study in children from 6 to 11 years old found a 0.7% rate (5 in 672) of uncorrected anisometropia,²⁷ similar to the 1.1% (8 in 749) found in the present study.

In the literature, the pattern of variation of anisometropia as a function of age and during the school period is not clear, presenting discordant results. Although many studies focus on children, it is common to have relatively wide age ranges. Most authors conclude that anisometropia varies with age,^{4,5,7,28} although there are also studies where this relationship

Table 5. Anisometropia prevalence studies. TA - Total Anisometropia; SA - Spherical Equivalent Anisometropia; MA - Meridional Anisometropia.

Author/ year	Location	Age (years)	Sample	Refractive test	Definition	Prevalence (%)
Ohlsson/ 2003 ²²	America Monterrey, Mexico	12-13	1035	Retinoscopy	AT ≥ 1.00	15
Dobson/ 2008 ¹³	Toronto, Canada	4-13	1041	Cycloplegic Autorefraction	SA ≥ 1.00 MA ≥ 1.00 TA ≥ 1.00	6.7 15 18.1
Deng/ 2012 ⁵	Boston, USA	5 12-15	395 312	Retinoscopy	AS ≥ 1.00	1.3 5.8
Quek/ 2004 ²³	Asia Singapore	15-19	946	N/Cycloplegic Autorefraction	SA ≥ 1.00	11.2
Yekta/ 2010 ²⁴	Shiraz, Iran	7-15	1872	N/Cycloplegic Autorefraction	SA ≥ 1.00	2.6
Hu/2016 ⁷	Shandong, China	4-18	6025	Cycloplegic Autorefraction	SA ≥ 1.00 MA ≥ 1.00	7
Lee/ 2017 ⁸	Taiwan, China	8	23114	Cycloplegic Autorefraction	SA ≥ 1.00	3.7
Alrahili/ 2017 ²⁵	Medina, Saudi Arabia	3-10	1893	N/Cycloplegic Autorefraction	TA ≥ 1.00	7.4
Hendriks/ 2009 ⁴	Europe Maastricht, Netherlands	11-13	520	N/Cycloplegic Autorefraction	SA ≥ 1.00	4.6
Flitcroft/ 2020 ¹¹	Ireland	6-7	362	Cycloplegic Autorefraction	SA ≥ 1.00	6.9
Huynh/ 2006 ²⁶	Oceania Sydney, Australia	6	1765	Cycloplegic Autorefraction	AS ≥ 1.00 AM ≥ 1.00	1.6 1.0

has not been found.^{10,13} Studies on the subject, at school age, which showed an increasing prevalence with age were carried out in populations with a high frequency of myopia, a condition whose prevalence increases in adolescence.²⁸ On the other hand, longitudinal studies show that the prevalence of anisometropia increases after children start attending school.^{5,7,25} Given these two lines that justify the variation of anisometropia during school age, it appears that they are related to each other, since the progress in the school path is accompanied by increasing age. In the present study, the anisometropia prevalence was also found to increase with advancement in the level of education. Consequently the age factor is also contributing to this situation, with myopic anisometropia being the one that most contributes to this variation pattern.

Regarding the influence of gender on anisometropia, contradictory data are found in the scientific literature. While in one study it is reported that the prevalence found was higher in males²⁸ in others it is reported that the prevalence rates are higher in females.^{10,23} The results of the present study revealed a higher frequency in females (7.1%) than in males (5.3%), however these differences were not statistically significant. This finding is in line with the results of other authors.^{9,13,25,26}

The influence of living in rural or urban areas has also been the object of study by several researchers, considering the development of myopia and, consequently, myopic anisometropia, which is more pronounced in urban areas.^{7,8,10} The present study did not prove whether the area of residence and the frequency of anisometropia were related. This parameter is highly dependent on the way in which each author classifies the area of residence, as rural or urban, and the limits of these regions are sometimes difficult to define. Also, living in a rural area and working in an urban area means that the daily experience of some populations turns out to be more urban, in both environments. Some studies show that lifestyle parameters, such as reading and writing habits and time spent indoors, contribute to the prevalence of anisometropia variation.^{7,8,10,11}

This study has several strengths. The study was carried out in children and adolescents in a school environment. This allows minimizing the potential bias that occurs in the sampling process and avoids overestimation of the problem, when the investigation is carried out in a clinical environment. For this study, spherical anisometropia and astigmatic anisometropia were considered. The latter being disregarded in several studies and there is a record that this anisometropia is the one that most varies in terms of ethnicity.⁹

Certain limitations can be pointed out in this study. Firstly, the use of autorefractometry without cycloplegia is highlighted, which is not the gold standard method of refraction. This fact limits the analysis of the distribution of the different types of refractive errors found in the population studied. Despite the use of an open field auto refractometer, recognized as an instrument with good agreement with cycloplegic retinoscopy and which eliminates the need for cycloplegia in children^{17,18} tends to underestimate hyperopia.^{17,19} However, for the present study, this situation does not weaken the conclusions, as the refraction was evaluated in an open field and binocularly, both eyes are exposed to the same conditions. In addition to that studies by other authors with the same methodology, point out a sensitivity of 100% for the diagnosis of anisometropia.¹⁹ Secondly, the choice of the cut-off point for the classification of anisometropia is pointed out. The literature recommends considering an IOD of at least 1.00D, however the sensitivity studies of the auto refractometer used, recommend considering 1.25D.¹⁶ Thirdly, the signalling of the area of residence of the participants as rural or urban is reported, since the limits of these regions were at times difficult to define. Noting also that being a study carried out in an area of the inner country, whose territorial classification is of low density, it is expectable that habits and behaviours are more uniform between rural and urban areas. This wouldn't be the case if the same study had been carried out in an area of greater population density.

For future studies, data regarding reading habits and time spent outdoors will be collected, since these can be risk factors for the development of refractive errors.

Conclusions

The present study estimated the prevalence of anisometropia in Portuguese children from preschool to the 3rd cycle of basic education finding an occurrence rate of 6.1%. The results of this work also showed that the level of the study cycle and the spherical anisometropia are related, verifying that it is low in preschool education and higher in the 3rd cycle of basic education. It was also found that, hyperopic anisometropia was more prevalent in younger children and that with the progress of the school path, myopic anisometropia predominated. Regarding anisometropia, 17% of the subjects were uncorrected, which can be associated to an absence of visual related symptoms due to a possible amblyopia. Taking into account the cases of uncorrected anisometropia, in our opinion the implementation of visual screening programs is essential for the timely detection and correction of possible eye problems. This course of action will lead to better development, learning and school outcomes.

Data availability

Underlying data

Dryad: Portuguese Children Refractive data - VER+ Project, <https://doi.org/10.5061/dryad.h44j0zpm5>.²⁹

This project contains the following underlying data:

- PortugueseChildrenRefractiveDataVERmaisProjectV2.xlsx

Data are available under the terms of the [Creative Commons Zero “No rights reserved” data waiver](#) (CC0 1.0 Public domain dedication).

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References

- Vincent SJ, Collins MJ, Read SA, *et al.*: **Myopic anisometropia: Ocular characteristics and aetiological considerations.** *Clin. Exp. Optom.* 2014; **97**(4): 291–307.
[PubMed Abstract](#) | [Publisher Full Text](#)
- Smith EL III, Hung LF, Arumugam B, *et al.*: **Observations on the relationship between anisometropia, amblyopia and strabismus.** *Vis. Res.* 2017; **134**: 26–42.
[Publisher Full Text](#) | [Free Full Text](#) | [PubMed Abstract](#)
- South J, Gao T, Collins A, *et al.*: **Aniseikonia and anisometropia: implications for suppression and amblyopia.** *Clin. Exp. Optom.* 2019; **102**(6): 556–565.
[PubMed Abstract](#) | [Publisher Full Text](#)
- Hendricks TJ, De Brabander J, Vankan-Hendricks MH, *et al.*: **Prevalence of habitual refractive errors and anisometropia among Dutch schoolchildren and hospital employees.** *Acta Ophthalmol.* 2009; **87**(5): 538–543.
[PubMed Abstract](#) | [Publisher Full Text](#)
- Deng L, Gwiazda JE: **Anisometropia in children from infancy to 15 years.** *Investig. Ophthalmol. Vis. Sci.* 2012; **53**(7): 3782–7.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
- Yoo YC, Kim JM, Park KH, *et al.*: **Refractive errors in a rural Korean adult population: the Namil Study.** *Eye.* 2013; **27**(12): 1368–1375.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
- Hu YY, Wu JF, Lu TL, *et al.*: **Prevalence and associations of anisometropia in Children.** *Investig. Ophthalmol. Vis. Sci.* 2016; **57**(3): 979–988.
[Publisher Full Text](#)
- Lee CW, Fang SY, Tsai DC, *et al.*: **Prevalence and association of refractive anisometropia with near work habits among young schoolchildren: The evidence from a population-based study.** *PLoS One.* 2017; **12**(3): 1–15.
[Publisher Full Text](#)
- Afsari S, Rose KA, Gole GA, *et al.*: **Prevalence of anisometropia and its association with refractive error and amblyopia in preschool children.** *Br. J. Ophthalmol.* 2013; **97**(9): 1095–1099.
[Publisher Full Text](#) | [PubMed Abstract](#)
- Wei S, Sun Y, Li S, *et al.*: **Refractive errors in university students in central China: the Anyang University Students Eye Study.** *Investig. Ophthalmol. Vis. Sci.* 2018; **59**(11): 4691–4700.
[Publisher Full Text](#)
- Flitcroft I, Mccullough S, Saunders K: **What can anisometropia tell us about eye growth?** *Br. J. Ophthalmol.* 2021; **105**: bjophthalmol-2020-316406–bjophthalmol-2020-311215.
[Publisher Full Text](#)
- Jeon HS, Choi DG: **Stereopsis and fusion in anisometropia according to the presence of amblyopia.** *Graefes Arch. Clin. Exp. Ophthalmol.* 2017; **255**(12): 2487–2492.
[PubMed Abstract](#) | [Publisher Full Text](#)
- Dobson V, Miller JM, Clifford-Donaldson CE, *et al.*: **Associations between anisometropia, amblyopia, and reduced stereoacuity in a school-aged population with a high prevalence of astigmatism.** *Investig. Ophthalmol. Vis. Sci.* 2008; **49**(10): 4427–4436.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
- Nunes AF, Monteiro PM, Ferreira FB, *et al.*: **Convergence insufficiency and accommodative insufficiency in children.** *BMC Ophthalmol.* 2019; **19**(1): 1–8.
[Publisher Full Text](#)
- Nunes AF, Sena F, Calado R, *et al.*: **Reduced visual acuity in children from 5 to 6 years old, with LEA chart.** *Graefes Arch. Clin. Exp. Ophthalmol.* 2021; **259**: 759–768.
[PubMed Abstract](#) | [Publisher Full Text](#)
- Silbert D, Matta N, Tian J, *et al.*: **Comparing the SureSight autorefractor and the plusoptix photoscreener for pediatric vision screening.** *Strabismus.* 2014; **22**(2): 64–67.
[PubMed Abstract](#) | [Publisher Full Text](#)
- Dikkaya F, Erdur SK: **Comparison of the PlusOptix S09 and Spot Vision photorefractor to cycloretinoscopy.** *Int. Ophthalmol.* 2018; **2018**: 3–10.
- Yilmaz I, Ozkaya A, Alkin Z, *et al.*: **Comparison of the Plusoptix A09 and Retinomax K-Plus 3 With Retinoscopy in Children.** *J. Ped. Ophthalmol. Strab.* 2015; **52**(1): 37–42. 2015.
- Fogel-Levin M, Doron R, Wygnanski-Jaffe T, *et al.*: **A comparison of plusoptix A12 measurements with cycloplegic refraction.** *J. AAPOS.* 2016; **20**(4): 310–4.
[PubMed Abstract](#) | [Publisher Full Text](#)
- Census 2011 Resultados por Freguesia.* Portugal: Instituto Nacional de Estatística; 2011 [cited 2021 Nov 23].
[Reference Source](#)
- Thibos LN, Wheeler W, Horner D: **Power vectors: an application of Fourier analysis to the description and statistical analysis of refractive error.** *Optom. Vis. Sci.* 1997; **74**(6): 367–375.
[PubMed Abstract](#) | [Publisher Full Text](#)
- Ohlsson J, Villarreal G, Sjöström A, *et al.*: **Visual acuity, amblyopia, and ocular pathology in 12- to 13-year-old children in Northern Mexico.** *J. AAPOS.* 2003; **7**(1): 47–53.
[PubMed Abstract](#) | [Publisher Full Text](#)
- Quek TP, Chua CG, Chong CS, *et al.*: **Prevalence of refractive errors in teenage high school students in Singapore.** *Ophthalmic Physiol. Opt.* 2004; **24**(1): 47–55.
[PubMed Abstract](#) | [Publisher Full Text](#)
- Yekta A, Fotouhi A, Hashemi H, *et al.*: **Prevalence of refractive errors among schoolchildren in Shiraz, Iran.** *Clin. Exp. Ophthalmol.* 2010; **38**(3): 242–248.
[PubMed Abstract](#) | [Publisher Full Text](#)
- Alrahili NHR, Jadidy ES, Alahmadi BSH, *et al.*: **Prevalence of uncorrected refractive errors among children aged 3-10 years in western Saudi Arabia.** *Saudi Med. J.* 2017; **38**(8): 804–810.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)

26. Huynh SC, Wang XY, Ip J, *et al.*: **Prevalence and associations of anisometropia and aniso-astigmatism in a population based sample of 6 year old children.** *Br. J. Ophthalmol.* 2006; **90**(5): 597–601.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
27. Lança C, Serra H, Prista J: **Strabismus, visual acuity, and uncorrected refractive error in Portuguese children aged 6 to 11 years.** *Strabismus.* 2014; **22**(3): 115–119.
28. Wajuihian SO, Mashige KP: **Gender and age distribution of refractive errors in an optometric clinical population.** *J. Optom.* 2021.
[Publisher Full Text](#)
29. Nunes AF, Batista MJ, Monteiro PL: **Portuguese Children Refractive data - VER+ Project.** 2021.
[Publisher Full Text](#)

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Carla Lança 

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² Comprehensive Health Research Center (CHRC), Escola Nacional de Saúde Pública, Universidade Nova de Lisboa, Lisboa, Portugal

The authors have revised the paper and addressed my previous comments. I still have 3 minor suggestions as described below.

Page 1 of 28: and page 7 of 28

- Please, delete " $\chi^2(3) = 10.918$;"

Page 5 of 28:

- Please, delete the final "e" from "componente".
- Please, delete "and by applying the central limit theorem, it can be considered that the violation of the assumptions does not have serious consequences."

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Refractive errors and strabismus

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Author Response 02 Jun 2022

Amelia Nunes, Universidade da Beira Interior, Portugal, Portugal

Dear reviewer,
All corrections have been made.
Thank you so much for your careful and valuable review.

Competing Interests: No competing interests were disclosed.

Version 2

Reviewer Report 24 December 2021

<https://doi.org/10.5256/f1000research.79990.r102249>

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Pedro M. Serra 

Research and Development Department, Ophthalmology Clinic Vista Sánchez Trancón, Badajoz, Spain

I would like to thank the authors for having implemented my recommendations in the current version of the manuscript. Generally, the manuscript improved considerably but it requires linguist editing.

Specific comments

Abstract:

- I recommend using the word prevalent instead of "frequent", it highlights the aim of the study.
- When possible avoid passive voice "*An increase in anisometropia with the educational stage, was found in this study*". May be better: This study found an increase in...

Introduction:

- "*Anisometropia is an ocular disorder characterized by an interocular difference (IOD) in refractive error. It represents a specific refractive condition where the two eyes of an individual, with similar sociodemographic, environmental, and genetic influences, can have asymmetric eye growth*"
Recommended - Anisometropia is an ocular disorder characterized by an interocular difference (IOD) in refractive error. It represents a specific refractive condition where the two eyes of an individual, can have asymmetric eye growth.
- "Scientific studies on the prevalence of anisometropia focus on children or adults, with less research being found in adolescence, table 1. Recommended: remove the word Scientific and place table 1 in the discussion.

Methods:

- I think it would be useful to indicate how rural and urban schools were segmented. For

instance, say rural Schools were defined when settled in a living area with less than X thousand inhabitants.

- "Only two volunteers were excluded." Be consistent with the terminology used, participants or volunteers?
- I believe Table 2 would be better placed in the results part.

Discussion

- The discussion needs to have the sentences shortened and the sentences need to be more objective.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Vision Sciences, Ophthalmic Optics.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Author Response 30 Dec 2021

Amelia Nunes, Universidade da Beira Interior, Portugal, Portugal

Thank you so much for the review. We have made the changes accordingly based on the comments.

Abstract:

I recommend using the word prevalent instead of "frequent", it highlights the aim of the study.

Response: The wording was replaced in the abstract and in the remaining text.

When possible avoid passive voice "*An increase in anisometropia with the educational stage, was found in this study*". May be better: This study found an increase in...

Response: The sentence was modified.

Introduction:

"Anisometropia is an ocular disorder characterized by an interocular difference (IOD) in refractive error. It represents a specific refractive condition where the two eyes of an individual, with similar sociodemographic, environmental, and genetic influences, can have asymmetric eye growth"

Recommended - Anisometropia is an ocular disorder characterized by an interocular difference (IOD) in refractive error. It represents a specific refractive condition where the two eyes of an individual, can have asymmetric eye growth.

Response: The sentence was modified.

"Scientific studies on the prevalence of anisometropia focus on children or adults, with less research being found in adolescence, table 1. Recommended: remove the word Scientific and place table 1 in the discussion.

Response: The word was removed and table 1 moved to the discussion section.

Methods:

I think it would be useful to indicate how rural and urban schools were segmented. For instance, say rural Schools were defined when settled in a living area with less than X thousand inhabitants.

Response: That segmentation wasn't done by this research team, it was provided by the municipalities representative. The following sentence was added to the sample characterization methods section "Rural and urban areas classification was based on the information provided by the municipalities, considering the residence area of each participant."

"Only two volunteers were excluded." Be consistent with the terminology used, participants or volunteers?

Response: The terminology was all changed to participants.

I believe Table 2 would be better placed in the results part.

Response: In the first version of the manuscript, table 2 was in the results section. However since it presented data regarding the sample characterization, the other reviewer requested that it should be moved to the methods section.

Discussion

The discussion needs to have the sentences shortened and the sentences need to be more objective.

Response: Several sentences have been changed in the discussion section.

Competing Interests: No competing interests were disclosed.

Reviewer Report 10 December 2021

<https://doi.org/10.5256/f1000research.79990.r102250>

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Carla Lança 

¹ Escola Superior de Tecnologia da Saúde de Lisboa (ESTeSL), Instituto Politécnico de Lisboa, Lisboa, Portugal

² Comprehensive Health Research Center (CHRC), Escola Nacional de Saúde Pública, Universidade Nova de Lisboa, Lisboa, Portugal

The paper is much improved, and the authors have addressed most of my comments. However, I still have a few minor comments:

- Introduction: Table 1 should be moved to the discussion section. It is not common to see tables in the introduction section of scientific papers. The table needs a legend for the abbreviations mentioned.
- Results: Table 5: The values of Z(adjust) do not add much to the table and the p-value is best. I suggest deleting the Z(adjust) values.
- Conclusions: The authors refer that screening programmes are necessary. However, only 8 of the 46 participants did not have a correction, meaning that the majority had been already diagnosed. The conclusion needs further refinement.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Refractive errors and strabismus

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Author Response 30 Dec 2021

Amelia Nunes, Universidade da Beira Interior, Portugal, Portugal

Thank you so much for the review. We have made the changes accordingly based on the comments.

Introduction: Table 1 should be moved to the discussion section. It is not common to see tables in the introduction section of scientific papers. The table needs a legend for the abbreviations mentioned.

Response: Table 1 was moved to the discussion section (table and reference numbers will be updated)

Results: Table 5: The values of Z(adjust) do not add much to the table and the p-value is best. I suggest deleting the Z(adjust) values.

Response: Table 5, Z(adjust) deleted

Conclusions: The authors refer that screening programs are necessary. However, only 8 of the 46 participants did not have a correction, meaning that the majority had been already diagnosed. The conclusion needs further refinement.

Response: The last paragraph of the conclusion was changed to "Regarding anisometropia, 17% of the subjects were uncorrected, which can be associated to an absence of visual related symptoms due to a possible amblyopia. Taking into account the cases of uncorrected anisometropia, in our opinion the implementation of visual screening programs is essential for the timely detection and correction of possible eye problems. This course of action will lead to better development, learning and school outcomes."

Competing Interests: No competing interests were disclosed.

Version 1

Reviewer Report 19 November 2021

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**Pedro M. Serra**

Research and Development Department, Ophthalmology Clinic Vista Sánchez Trancón, Badajoz, Spain

General comment

Thank you for considering my name as a reviewer of the manuscript titled “Frequency of anisometropia in children and adolescents”. I would like to congratulate the authors for their work in this field of vision sciences which has a special interest in countries where is a shortage of epidemiologic data in the field of vision.

Regarding the manuscript, my feeling is that it requires additional work before it is considered for indexing. In this report I will cover the technical issues that in my opinion would improve the quality of the manuscript, however, I would recommend the author's linguistic editing of the final manuscript. Examples of linguistic improvement are very long sentences with multiple ideas and some lack of concise writing.

Specific topics

Abstract: Provide a statement defining the topic of research and a second sentence where you state the aim of the study (eg. This study aims to estimate the prevalence of anisometropia in the Portuguese population of children and adolescents.) I suggest changing the word frequency to prevalence throughout the text.

Methods:

- Indicate the study design? (e.g. Observational Cross-sectional study)
- How did you build the sample?
- Describe the dependent and independent variables
- Remove any data from the methods

Results

- Use direct messages (e.g. No association was found between the presence of anisometropia with gender or area of residence)

Conclusion

- The first sentence should be deleted this is not a conclusion from the present study.

Introduction:

I think the introduction requires some improvement

- 1st paragraph – Provides a definition of the research topic
- “Anisometropia is an ocular disorder characterized by an interocular difference (IOD) in refractive error, representing a specific refractive condition insofar as the two eyes of an individual, with presumably similar sociodemographic, environmental and genetic influences, can have asymmetric eye growth.” Please reformulate this sentence, particularly remove the word presumably.
- 2nd paragraph and 3rd paragraph – mention the risk factors for anisometropia and the importance of assessing it
- 4th paragraph- describes the instrument used. I would suggest moving this information to the methods
- 5th paragraph- states the aim of the study.
- Missing information- the authors should mention the prevalence studies published, especially in Portugal, and compare with other European countries.

Methods:

Please include:

- Type of study
- Nature of the sample, how did you select the different groups? There are differences in the socioeconomic nature of the study sites? Please indicate how did you define Rural and Urban populations? (e.g. number of inhabitants covered by each school)?
- Please indicate specifically the region where this study was conducted, this is important for instance in future meta-analysis studies.
- Duration of the study (e.g September 2021 – November 2021)
- Could you add information about the use of spectacles, you could try to see if the anisometropia had already been identified.

Instrument description

- Include PlusOptix manufacturer city and country
- Provide the repeatability of the instrument (published)

This is just a comment - “ Students' data for which it was not possible to obtain refraction were excluded, due to technical issues associated with the performance of the instrument (presence of strabismus, opacities, retinal anomalies or when the refractive error exceeded the instrument's measurement limit - spherical measurement range or cylindrical from -7.00 to $+5.00D$) or due to

lack of cooperation from the participant.”

This is probably one of the most valuable pieces of information from the data collection and it is a shame not being presented.

Data Analysis

- Please indicate how the reader can interpret Thibos' notation in regards to the J0 and J45.
- Say that the Cylinder component needs to be in negative form

Anisometropia Classification

- I suggest writing the formulas used for calculating the SA, MA, and sMA.

Statistical Analysis

Results

- Sample characterization – 1st paragraph move it to the methods section.
- Refractive State
 - Please provide a table or figure (Box plot) with the refractive error information, where is possible to see the mean, standard deviation and range
 - Figure 1 has limited information, I suggest including the percentages in the table mentioned above
- Anisometropia
 - Please, use written numbers when placing them at the beginning of a sentence. (e.g Forty-six not 46)
 - Provide information about the level of anisometropia per type. Describe the mean, standard deviation, and range
 - Suggest creating a figure (bar plot with the percentages of anisometropia, total, young age group and older age group)

Discussion

- The authors found a statistically significant association between the frequency of myopic anisometropia and age/ scholarly. Could the authors extend the discussion on the etiology of myopic anisometropia, which probably implies an asymmetric eye growth? Discussing this point could help the authors to suggest actions/mechanisms to prevent anisometropia.
- Discuss the consequences of hyperopic anisometropia, use the values (mean and standard deviation) for arguing about the number of subjects in risk of developing amblyopia.

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Vision Sciences, Ophthalmic Optics.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 30 Nov 2021

Amelia Nunes, Universidade da Beira Interior, Portugal, Portugal

We thank the reviewer for his time and very constructive comments. We appreciate the reviewers' voluntary contributions in the form of helpful comments that allowed us to strengthen our article. We updated the article according to your comments.

Specific topics

Abstract: Provide a statement defining the topic of research and a second sentence where you state the aim of the study (eg. This study aims to estimate the prevalence of anisometropia in the Portuguese population of children and adolescents.) I suggest changing the word frequency to prevalence throughout the text.

R: The abstract was modified to include the topic and the aims "This research was developed to study the epidemiology of anisometropia. It aims to estimate the prevalence of anisometropia in Portuguese children and adolescents at various educational stages, studying its association with sociodemographic variables"

Methods:

- Indicate the study design? (e.g. Observational Cross-sectional study)
- How did you build the sample?

- Describe the dependent and independent variables
- Remove any data from the methods

R: All information was included and data was removed. The sample was collected from several kindergartens and schools in the central region of Portugal. The central region was included in the abstract and more details were added to the methods section.

Results

- Use direct messages (e.g. No association was found between the presence of anisometropia with gender or area of residence)

R: Section changed

Conclusion

- The first sentence should be deleted this is not a conclusion from the present study.

R: Section changed

Introduction:

I think the introduction requires some improvement

- 1st paragraph – Provides a definition of the research topic
- “Anisometropia is an ocular disorder characterized by an interocular difference (IOD) in refractive error, representing a specific refractive condition insofar as the two eyes of an individual, with presumably similar sociodemographic, environmental and genetic influences, can have asymmetric eye growth.” Please reformulate this sentence, particularly remove the word presumably.
- 2nd paragraph and 3rd paragraph – mention the risk factors for anisometropia and the importance of assessing it
- 4th paragraph- describes the instrument used. I would suggest moving this information to the methods
- 5th paragraph- states the aim of the study.
- Missing information- the authors should mention the prevalence studies published, especially in Portugal, and compare with other European countries.

R: All information was included. A new table (new table 1) was introduced containing prevalence studies. We did not find any studies regarding anisometropia prevalence in Portugal, in indexed research papers. We found an indexed research paper by Lança, Serra, and Prista in Portuguese children, which indirectly refers to the number of uncorrected anisometropic children, but the methodology is very different from ours, including the anisometropia classification criterium. However, the percentage of uncorrected

anisometropia is similar. We considered this fact relevant and it was included in the discussion.

Methods:

Please include:

- Type of study
- Nature of the sample, how did you select the different groups? There are differences in the socioeconomic nature of the study sites? Please indicate how did you define Rural and Urban populations? (e.g. number of inhabitants covered by each school)?
- Please indicate specifically the region where this study was conducted, this is important for instance in future meta-analysis studies.
- Duration of the study (e.g September 2021 – November 2021)
- Could you add information about the use of spectacles, you could try to see if the anisometropia had already been identified.

R: This information is important and was included to some extent in the methods section. Rural and Urban definitions were based on the information provided by the municipalities representative.

Instrument description

- Include PlusOptix manufacturer city and country
- Provide the repeatability of the instrument (published)

This is just a comment - " Students' data for which it was not possible to obtain refraction were excluded, due to technical issues associated with the performance of the instrument (presence of strabismus, opacities, retinal anomalies or when the refractive error exceeded the instrument's measurement limit - spherical measurement range or cylindrical from -7.00 to $+5.00D$) or due to lack of cooperation from the participant."

This is probably one of the most valuable pieces of information from the data collection and it is a shame not being presented.

R: Information included. Although a study reports repeatability of around 0,6D for MSE with the A09 model (Plusoptix Vision Screener: the accuracy and repeatability of refractive measurements using a new autorefractor) this and other studies are not focused on anisometropia, for which IOD MSE errors could be minimized. Another study with a different plus optix model, reports a sensitivity of 100% for anisometropia (A comparison of plusoptiX A12 measurements with cycloplegic refraction). We included this study in the introduction.

Data Analysis

- Please indicate how the reader can interpret Thibos' notation in regards to the J0 and J45.
- Say that the Cylinder component needs to be in negative form

R: This information has been added

Anisometropia Classification

- I suggest writing the formulas used for calculating the SA, MA, and sMA.

R: The formulas were added

Statistical Analysis**Results**

- Sample characterization – 1st paragraph move it to the methods section.

R: Paragraph moved

- Refractive State
 - Please provide a table or figure (Box plot) with the refractive error information, where is possible to see the mean, standard deviation, and range
 - Figure 1 has limited information, I suggest including the percentages in the table mentioned above

R: A new table (table 4) containing this data was added to this section

- Anisometropia
 - Please, use written numbers when placing them at the beginning of a sentence. (e.g Forty-six not 46)
 - Provide information about the level of anisometropia per type. Describe the mean, standard deviation, and range
 - Suggest creating a figure (bar plot with the percentages of anisometropia, total, young age group and older age group)

R: Sentence rewritten

Mean, standard deviation, and range of anisometropia per type was added in table 4. An extra figure would duplicate the information.

Information about the age group is already included in table 5, distributed by the study cycle which indirectly represents age groups. An extra figure would duplicate the information.

Discussion

- The authors found a statistically significant association between the frequency of

myopic anisometropia and age/ scholarly. Could the authors extend the discussion on the etiology of myopic anisometropia, which probably implies an asymmetric eye growth? Discussing this point could help the authors to suggest actions/mechanisms to prevent anisometropia.

R: This is an excellent suggestion for future research. We can hypothesise that an excess of near-work activities, associated with incorrect posture, can lead to asymmetric eye growth. However, those factors were not controlled in the present study.

- Discuss the consequences of hyperopic anisometropia, use the values (mean and standard deviation) for arguing about the number of subjects at risk of developing amblyopia.

R: Only 2 uncorrected anisometropes were hyperopic, and since no BCVA data was collected, we feel that there are no sufficient data to support this kind of analysis. However, we agree that it is an excellent suggestion for future work.

Competing Interests: No competing interests.

Reviewer Report 12 November 2021

<https://doi.org/10.5256/f1000research.77322.r98416>

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? **Carla Lança** 

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² Comprehensive Health Research Center (CHRC), Escola Nacional de Saúde Pública, Universidade Nova de Lisboa, Lisboa, Portugal

The study reports on the prevalence of anisometropia in a sample of Portuguese children and adolescents. The wording needs major revision. I have several comments as shown below.

Title

- I suggest replacing the word “frequency” by “prevalence”. This suggestion also applies throughout all sections of the manuscript.

Abstract

- Methods - Please replace “cycloplegic” by “cycloplegia”.
- Results - Please revise the wording of the following sentence “to state that the occurrence...”; The last sentence of the results it’s not clear and should be revised.

Introduction

- The first sentence is too long, and the wording needs to be revised. I suggest splitting it into two sentences. I have a similar comment for the third paragraph of the introduction section.

- There is no mention to previous studies on anisometropia prevalence. Also, there is the need to show more detailed results on the studies reporting risk factors and its association with anisometropia (e.g., sample size, age, p values, etc.).

Methods

- The methods section is incomplete. The methods section of a research paper provides the information by which a study's validity is judged. Therefore, it requires a clear and precise description of how an experiment was done, and the rationale for why specific experimental procedures were chosen. For example, more information is necessary on the sampling method and authors should describe their study design.

Results

- The first paragraph should be moved to the methods section.
- Table 2 – Replace “statistical test” by p value only (follow the same recommendation in the text results). Also, include a note referring to which comparisons are being made (for example, is it the distribution of children by cycles or the age by cycles?).
- At the time you are writing your article, you have already completed your study, so you should use past tense in your methodology and results section to record what you did and found (for example, “this difference was statistically significant”).
- Refractive state and anisometropia sections need to be re-written, as it is confusing to present two percentages at the same time. Perhaps the authors can consider showing separate sentences for those results.
- Influence of sociodemographic variables: the first sentence of this section should be moved to the statistical analysis; Delete “therefore this parameter is not in the table” and replace by the p value.
- Table 3 – delete the X2 value and only present p value. Non-significant p values may be presented with only 2 decimal places.
- For risk factor analysis the multivariate adjusted analysis should be additionally shown.
- Figure 2. The colour of the legend is not clear, and it is difficult to distinguish the categories presented in the graph. The y axis wording needs revision.

Discussion

- Please, delete the 1st sentence.
- The differences between prevalence of anisometropia in Asia and Europe need a more careful explanation. Environmental factors play a major role in the development of refractive errors, especially myopia.
- Another limitation of the study that was not referred is that factors such as reading habits or outdoor time were not collected and those may be risk factors for the development of refractive errors.
- Is this the first study in Portugal? Are your results comparable with other studies in

Portugal?

Conclusions

- Please revise the wording on the sentence that includes the following: “we are of the opinion”.

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Refractive errors and strabismus

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 30 Nov 2021

Amelia Nunes, Universidade da Beira Interior, Portugal, Portugal

We would like to thank the reviewer for her valuable time and comments on our article; this will be very useful for us in future research and has allowed us to improve this document. We have made the required corrections.

Title

- I suggest replacing the word “frequency” by “prevalence”. This suggestion also applies throughout all sections of the manuscript.

R: The title was replaced

Abstract

- Methods - Please replace “cycloplegic” by “cycloplegia”.

R: The word was replaced

- Results - Please revise the wording of the following sentence “to state that the occurrence...”; The last sentence of the results it’s not clear and should be revised.

R: Sentence revised to “No statistical differences were found between genders or between areas of residence regarding the rate of anisometropia”;

Last sentence revised to “Regarding spherical equivalent anisometropia, there is a pattern of variation that increases with the cycle of studies ($\chi^2_{(3)} = 10.918$; $p = 0.012$), with myopic anisometropia being the main contributor to this variation.”

Introduction

- The first sentence is too long, and the wording needs to be revised. I suggest splitting it into two sentences. I have a similar comment for the third paragraph of the introduction section.

R: The first sentence was split and wording revised to: “Anisometropia is an ocular disorder characterized by an interocular difference (IOD) in refractive error. It represents a specific refractive condition where the two eyes of an individual, with presumably similar sociodemographic, environmental and genetic influences, can have asymmetric eye growth.”

The third paragraph split and wording revised to: “Although it is not clear what is the ideal age to perform the correction, in order to guarantee an ideal visual development and maturation, the early correction of anisometropia is important.¹¹ This prevents the development of other changes such as aniseikonia, amblyopia and strabismus^{3,12,13} and even in small degrees (<1D) facilitates emmetropization.¹¹ It also improves quality of life, reducing or eliminating symptoms of visual discomfort.”

- There is no mention to previous studies on anisometropia prevalence. Also, there is the need to show more detailed results on the studies reporting risk factors and its association with anisometropia (e.g., sample size, age, p values, etc.).

R: These data were introduced in a new table, and the reference numbering was changed accordingly.

Methods

- The methods section is incomplete. The methods section of a research paper provides the information by which a study's validity is judged. Therefore, it requires a clear and precise description of how an experiment was done, and the rationale for why specific experimental procedures were chosen. For example, more information is necessary on the sampling method and authors should describe their study design.

R: The method section was completed including the following text “Data from the Portuguese Census 2011, shows a population of 319284 from 0 to 14 years old in the central region. For a confidence level of 95% and a 5% margin of error, taking into account that the prevalence of the studied condition is unknown, it was fixed at 50% to obtain a large enough sample size. The result was a minimum of 384 subjects. The data collection took place in 5 schools of the central region of Portugal, including all students that were authorized to participate by their legal guardians.”

Results

- The first paragraph should be moved to the methods section.

R: The paragraph was moved

- Table 2 – Replace “statistical test” by p value only (follow the same recommendation in the text results). Also, include a note referring to which comparisons are being made (for example, is it the distribution of children by cycles or the age by cycles?).

R: Done. This table was moved to the methods section, and the statistical analysis was deleted since it did not provide significant information.

- At the time you are writing your article, you have already completed your study, so you should use past tense in your methodology and results section to record what you did and found (for example, “this difference was statistically significant”).

R: Text rewritten to past tense.

- Refractive state and anisometropia sections need to be re-written, as it is confusing to present two percentages at the same time. Perhaps the authors can consider showing separate sentences for those results.

R: Both sections were rewritten to avoid double percentages.

- Influence of sociodemographic variables: the first sentence of this section should be moved to the statistical analysis; Delete “therefore this parameter is not in the table” and replace by the p-value.

R: The sentence was moved to the methods section. “Therefore..” was removed and the p-value information was added to the table.

- Table 3 – delete the X2 value and only present p-value. Non-significant p values may be presented with only 2 decimal places.

R: X2 values deleted and p values with 2 decimal places

- For risk factor analysis the multivariate adjusted analysis should be additionally shown.

R: The multivariate analysis was added to the table.

- Figure 2. The colour of the legend is not clear, and it is difficult to distinguish the categories presented in the graph. The y axis wording needs revision.

R: Legend colour changed. Y-axis caption revised.

Discussion

- Please, delete the 1st sentence.

R: Sentence deleted

- The differences between prevalence of anisometropia in Asia and Europe need a more careful explanation. Environmental factors play a major role in the development of refractive errors, especially myopia.

R: An extra sentence was added to explain to acknowledge the contribution of environmental factors “Some studies show that lifestyle parameters, such as reading and writing habits and time spent indoors, contribute to the prevalence of anisometropia variation. ^{7,8,10,11}”

- Another limitation of the study that was not referred to is that factors such as reading habits or outdoor time were not collected and those may be risk factors for the development of refractive errors.

R: We recognise the relevance of these factors, and they will be included in future studies. Accordingly to your suggestions, the following sentence was added to the end of the text "For future studies, data regarding reading habits and time spent outdoors will be collected, since these can be risk factors for the development of refractive errors."

- Is this the first study in Portugal? Are your results comparable with other studies in Portugal?

R: This is not the first study in Portugal, however in indexed research papers we couldn't find any comparable studies for Portugal. We found an indexed research paper by Lança, Serra, and Prista in Portuguese children, which indirectly refers to the number of uncorrected anisometropic children, but the methodology is very different from ours, including the anisometropia classification criterium. However, the percentage of uncorrected anisometropia is similar. We considered this fact relevant and it was included in the discussion.

Conclusions

- Please revise the wording on the sentence that includes the following: "we are of the opinion".

R: The sentence was revised and divided to: "Taking into account the high frequency of anisometropia found in 3rd cycle students, in our opinion the implementation of visual screening programs at this age is essential for the timely detection and correction of possible eye problems. This course of action will lead to better development, learning, and school outcomes at these ages."

Competing Interests: No competing interests.

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