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· 生长发育与健康监测 ·

云南少数民族地区学龄儿童等效球镜度数屈光参差分布及眼生物学参数

戴雅伊[1],黄达峰[2],常利涛[2],苏晨曦[1],韦蝶心[2],张金娇[1],谢雪妮[1],肖洁[1],黄莹[1]

1.昆明医科大学公共卫生学院,云南 650500;2.云南省疾病预防控制中心学校卫生所

【摘要】 目的 分析云南少数民族地区学龄儿童等效球镜度数(SE)屈光参差的分布及相关因素,为 SE 屈光参差的干预控制提供科学依据。**方法** 2021 年 10 月采用多阶段整群随机抽样方法,对云南省丽江市、大理市、西双版纳州 3 个县/市的 1 852 名小学和初中学生进行非睫状肌麻痹电脑验光视力检查和问卷调查,获得人口学特征、眼球生物学参数及 SE 数据,计算 SE 屈光参差。组间比较采用 Mann-Whitney *U* 检验或 Kruskal-Wallis *H* 检验,采用 Logistic 回归探索学龄儿童 SE 屈光参差的相关因素。**结果** 学龄儿童屈光参差检出率为 23.0%,女生检出率(24.2%)高于男生(21.6%)。SE 屈光参差的学龄儿童与无屈光参差者相比,眼轴(AL)[24.03(23.41,24.76),23.93(23.26,24.61) mm]和角膜曲率半径(CR)[43.42(42.43,44.42),43.14(42.23,44.04) mm]较长,SE[-1.75(-2.75,-1.00),-0.94(-2.63,-0.25) D]、球镜屈光度[-1.38(-2.38,-0.75),-0.75(-2.38,0) D]较小,前房深度(ACD)[3.77(3.62,3.93),3.72(3.55,3.89) mm]较长,AL 差值[0.58(0.32,0.82),0.13(0.06,0.22) mm]、ACD 差值[0.05(0.02,0.08),0.03(0.01,0.06) mm]和 AL/CR 差值[0.01(0.01,0.02),0.01(0.00,0.01)]更大($Z=-22.47\sim-2.41$,*P* 值均<0.05)。Logistic 回归分析结果显示,轻度近视(*OR*=2.74)、中度近视(*OR*=3.52)、高度近视(*OR*=8.92)的学龄儿童 SE 屈光参差的发生风险相对较高(*P* 值均<0.05)。**结论** 云南少数民族地区学龄儿童 SE 屈光参差检出率较高,SE 屈光参差的检出率和参差程度与近视程度及部分屈光参数相关。

【关键词】 等效球镜度数;屈光,眼;回归分析;儿童;少数民族

【中图分类号】 R 179 R 770.42^{+1} R 778.1^{+1} **【文献标识码】** A **【文章编号】** 1000-9817(2025)11-1630-06

Distribution of spherical equivalent anisometropia and ocular biometric parameters in school-aged children in ethnic minority areas of Yunnan Province

DAI Yayi*, HUANG Dafeng, CHANG Litao, SU Chenxi, WEI Diexin, ZHANG Jinjiao, XIE Xueni, XIAO Jie, HUANG Ying

* *School of Public Health, Kunming Medical University, Kunming* 650500, *Yunnan Province, China*

【Abstract】 Objective To analyze the distribution and related factors of spherical equivalent(SE) anisometropia in school-aged children in ethnic minority areas of Yunnan Province, so as to provide a scientific basis for the intervention and control of SE anisometropia. **Methods** In October 2021, a total of 1 852 school-aged children in three counties/cities(Lijiang City, Dali City, Xishuangbanna) in Yunnan Province were examined by multi-stage cluster random sampling method for computer optometry visual acuity examination for non-ciliary paralysis and questionnaire survey.Demographic characteristics, ocular biological parameters and SE data were obtained for SE anisometropia. Group comparisons were conducted using Mann-Whitney *U* test or Kruskal-Wallis *H* test, and Logistic regression was used to explore the related factors of anisometropia in SE. **Results** The prevalence of SE anisometropia among school-age children was 23.0%, and the prevalence was higher in girls (24.2%) than that in boys (21.6%). Compared with non-anisometropic children, school-aged children with SE anisometropia had longer axial length (AL) [24.03 (23.41, 24.76), 23.93 (23.26, 24.61) mm] and corneal curvature radius (CR) [43.42 (42.43, 44.42), 43.14 (42.23, 44.04) mm], SE [-1.75(-2.75, -1.00), -0.94(-2.63, -0.25) D], smaller spherical scope [-1.38(-2.38, -0.75), -0.75(-2.38, 0) D], deeper anterior chamber depth(ACD) [3.77(3.62, 3.93), 3.72(3.55, 3.89) mm], and grater differences in AL[0.58(0.32, 0.82), 0.13 (0.06, 0.22) mm], ACD[0.05(0.02, 0.08), 0.03(0.01, 0.06) mm] and AL/CR[0.01(0.01, 0.02), 0.01(0.00, 0.01)] ($Z=-22.47$ to -2.41, all $P<0.05$). The results of Logistic regression showed that mild myopia(*OR*=2.74), moderate myopia(*OR*=3.52), and high myopia(*OR*=8.92) had a relatively high risk of anisometropia SE in school-aged children(all $P<0.05$). **Conclusion** The prevalence of SE anisometropia in school-aged children in ethnic minority areas of Yunnan Province is relatively high, and the prevalence and degree of anisometropia were closely related to myopia degree and related refractive parameters.

【Keywords】 Spherical equivalent; Refraction, ocular; Regression analysis; Child; Minority groups

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【作者简介】 戴雅伊(1998-),女,云南宣威人,在读硕士,主要研究方向为儿童青少年健康。

【通信作者】 黄莹,E-mail:huangying02.163.com

屈光参差指双眼屈光状态的不同,包括屈光性质和(或)屈光程度存在差异[1],通常定义为双眼等效球镜度数(spherical equivalent, SE)差值≥1.00 D[2-5]。屈光参差通常被认为是由左右眼轴长的差异引起的,但也有其他证据表明屈光参差可归因于眼生物学参数的差异[6-7]。在一些以学校为基础的横断面研究中,学龄儿童屈光参差的检出率为 2.9%~25.6%[4, 8-12]。屈光参差若不及时矫正,可导致视力较差的单眼视力下降更快、近视度数更高[13],或形成单眼弱视、外斜视等,对个体眼发育产生很大影响。本研究在云南少数民族地区对学龄儿童进行调查,探讨 SE 屈光参差的分布及眼球生物学参数的特征,为早期 SE 屈光参差干预控制提供科学依据与前瞻性指导。

1　对象与方法

1.1　对象　2021 年 10 月,采用多阶段整群随机抽样的方法抽取调查对象。第一阶段,在云南省丽江市、大理市、西双版纳州根据经济状况分别在每个县/市直接抽取经济状况好和差的乡镇;第二阶段,在所有乡镇中依据学校等级、民族情况及学校人数等因素按比例抽取学校,共选出 3 所小学和 4 所初级中学;第三阶段,被抽中的学校直接抽取一定数量的班级,抽中的班级学生全部纳入调查,最终在 3 个地区抽取小学三至五年级、初中八和九年级共计 1 852 名中小学生。年龄范围 7~20 岁,平均年龄为(11.74±2.31)岁,其中男生 869 名,女生 983 名。本研究获得昆明医科大学伦理委员会批准(批号:KMMU2025MEC063)。学生及监护人均了解调查内容并签署知情同意书。

1.2　方法

1.2.1　检查方法　在每所学校设置站点,采用问卷收集学生的人口学特征、健康相关行为、环境影响因素等资料。调查问卷参照全国学生视力不良及影响因素专项调查表[14],咨询专家对问卷内容进行调整修改,在进行预实验后确定问卷内容,保证问卷的信、效度良好,其中 Cronbach α 系数为 0.86, *KMO* = 0.85, 巴特利球形检验 $P<0.01$。采用国际标准对数视力表对儿童进行裸眼视力检查,由专业眼科医师排除眼部器质性病变及眼部手术史,在非睫状肌麻痹条件下,使用台式全自动电脑验光仪(型号为 AR-1),记录球镜值、柱镜值,SE = 球镜值 + 1/2 柱镜值。采用光干涉式眼轴长测量仪 AL-Scan 测量眼轴(axial length, AL)、角膜曲率半径(curvature radius, CR)、中央角膜厚度(central corneal thickness, CCT)、前房深度(anterior chamber depth, ACD)、角膜直径(white-to-white, WTW)等眼球生物学参数。

1.2.2　诊断标准　根据《儿童青少年近视防控适宜技术指南》[15],裸眼视力<5.0 且非睫状肌麻痹下电脑验光 SE<-0.50 D 为近视判定标准。近视程度:-3.00< SE≤-0.50 D 为轻度近视,-6.00<SE≤-3.00 D 为中度近视,SE≤-6.00 D 为高度近视。散光程度[16]:0.50≤|柱镜|<1.00 D 为轻度散光,1.00≤|柱镜|<2.00 D 为中度散光,|柱镜|≥2.00 D 为高度散光。双眼 SE 差值≥1.00 D 定义为 SE 屈光参差。屈光参差被分为 3 个亚组:SE 屈光参差、球镜屈光参差、柱镜屈光参差。SE 屈光参差 = |右眼 SE-左眼 SE|;球镜屈光参差 = |球镜右眼屈光度-球镜左眼屈光度|;柱镜屈光参差 = |柱镜右眼屈光度-柱镜左眼屈光度|。另外,计算眼球生物学参数的差值采用|右眼-左眼|,眼球生物学参数采用左右眼数据的平均值。

1.3　质量控制　由专业人员对学龄儿童进行眼科检查,所有调研人员统一进行标准培训。眼科仪器均由专业的仪器设备维护人员进行校准。调查过程中按每天 5%比例抽取复测对象,对左右眼裸眼视力、球镜值、柱镜值及眼球生物学参数进行复测,发现检测数据可疑进行重复性检验。

1.4　统计学分析　采用 SPSS 26.0 软件进行统计分析。因连续变量不符合正态分布,故采用 $M(P_{25}, P_{75})$ 进行描述;分类变量采用频数和百分率描述。采用 χ^2 检验比较不同组间学龄儿童屈光参差的检出率。采用秩和检验对不同组间屈光参数进行差异性分析,其中两组变量采用 Mann-Whitney *U* 检验,3 组及以上采用 Kruskal-Wallis *H* 检验。采用 Spearman 相关分析探索变量间的相关性。采用 Logistic 回归(Stepwise 法)分析 SE 屈光参差相关因素。双侧检验水准 $\alpha = 0.05$。

2　结果

2.1　学龄儿童 SE 屈光参差检出率　学龄儿童屈光参差检出率为 23.0%(426/1 852),女生检出率(24.2%, 238/983)高于男生(21.6%, 188/869),差异无统计学意义($\chi^2 = 1.73$, $P>0.05$)。7~9 岁学龄儿童屈光参差检出率为 13.8%(66/478),10~12 岁为 26.8%(106/395),≥13 岁为 25.9%(254/979),差异有统计学意义($\chi^2 = 30.88$, $P<0.01$);初中生屈光参差检出率(26.3%, 261/994)高于小学生(19.2%, 165/858),差异有统计学意义($\chi^2 = 12.84$, $P<0.01$)。各民族间屈光参差检出率傣族最高(26.9%, 79/294),汉族次之(24.2%, 160/661),白族(22.3%, 53/238)、哈尼族(21.8%, 65/298)、其他民族(21.0%, 21/100)较低,差异无统计学意义($\chi^2 = 6.70$, $P>0.05$)。

2.2　不同近视程度学龄儿童 SE 屈光参差检出率比较　中度(33.3%, 140/420)和高度近视(33.3%, 28/84)的学龄儿童屈光参差检出率高于轻度近视(30.8%, 191/

621)和不近视(9.2%,67/727)的学龄儿童,差异有统计学意义($\chi^2=129.47$,$P<0.01$)。

2.3　学龄儿童 SE 屈光参差与屈光参数　学龄儿童双眼平均 AL 长度和 CR 分别为 23.94(23.30,24.65)、43.20(42.27,44.09) mm,双眼 SE、球镜和柱镜值屈光度分别为-1.25(2.69,-0.38)、-1.00(-2.38,-0.13)、-0.50(-0.75,-0.25) D。双眼平均 ACD、CCT、WTW、AL/CR 分别为 3.73(3.56,3.90) mm、552.00(529.75,573.50) μm、11.85(11.55,12.10) mm、0.56(0.53,0.58)。双眼 SE 屈光参差、球镜屈光参差和柱镜屈光参差分别为 0.38(0.13,0.88)、0.50(0.25,0.75)和 0.25(0.00,0.50) D,AL 差值、CR 差值分别为 0.16(0.07,0.34)、0.19(0.09,0.34) mm。ACD 差值、CCT 差值、WTW 差值、AL/CR 差值分别为 0.04(0.02,0.06) mm、4.00(2.00,7.00) μm、0.10(0.00,0.20) mm、0.01(0.00,0.01)。

2.4　是否有 SE 屈光参差学龄儿童屈光参数的比较　与无 SE 屈光参差的学龄儿童相比,有 SE 屈光参差的学龄儿童 AL 和 CR 较长,SE、球镜较小,ACD 较长,双眼 SE 屈光参差、球镜屈光参差、柱镜屈光参差、AL 差值和 ACD 差值、AL/CR 差值更大,差异均有统计学意义(P 值均<0.05)。见表 1。

2.5　学龄儿童 SE 屈光参差程度　用上述单因素分析中有统计学意义的因素分析 SE 屈光参差程度的相关因素。结果显示,AL、AL 差值、CR、ACD、ACD 差值、AL/CR 差值与 SE 屈光参差值有正相关关系(r 值分别为 0.10,0.52,0.07,0.10,0.12,0.40,P 值均<0.05)。见图 1。

表 1　学龄儿童屈光参数在有无等效球镜度数屈光参差间比较[$M(P_{25},P_{75})$]

Table 1　Comparison of refractive parameters among school-aged children with and without SE anisometropia[$M(P_{25},P_{75})$]

屈光参数	有 SE 屈光参差	无 SE 屈光参差	Z 值	P 值
AL/mm	24.03(23.41,24.76)	23.93(23.26,24.61)	-2.41	0.02
CR/mm	43.42(42.43,44.42)	43.14(42.23,44.04)	-3.59	<0.01
SE/D	-1.75(-2.75,-1.00)	-0.94(-2.63,-0.25)	-6.68	<0.01
球镜/D	-1.38(-2.38,-0.75)	-0.75(-2.38,0.00)	-6.08	<0.01
柱镜/D	-0.50(-0.88,-0.38)	-0.50(-0.75,-0.25)	-5.77	<0.01
ACD/mm	3.77(3.62,3.93)	3.72(3.55,3.89)	-4.21	<0.01
CCT/μm	552.00(532.50,573.13)	552.00(528.50,573.50)	-0.81	0.42
WTW/mm	11.80(11.55,12.10)	11.85(11.55,12.15)	-1.40	0.16
AL/CR	0.56(0.53,0.58)	0.56(0.53,0.58)	-0.52	0.60
SE 屈光参差/D	1.50(1.13,2.03)	0.25(0.13,0.50)	-31.53	<0.01
球镜屈光参差/D	1.50(1.25,2.00)	0.25(0.25,0.50)	-30.70	<0.01
柱镜屈光参差/D	0.25(0.00,0.50)	0.25(0.00,0.50)	-4.03	<0.01
AL 差值/mm	0.58(0.32,0.82)	0.13(0.06,0.22)	-22.47	<0.01
CR 差值/mm	0.20(0.08,0.35)	0.19(0.09,0.34)	-0.16	0.87
ACD 差值/mm	0.05(0.02,0.08)	0.03(0.01,0.06)	-6.49	<0.01
CCT 差值/μm	4.00(2.00,8.00)	4.00(2.00,7.00)	-0.41	0.68
WTW 差值/mm	0.10(0.00,0.20)	0.10(0.00,0.20)	-0.76	0.45
AL/CR 差值	0.01(0.01,0.02)	0.01(0.00,0.01)	-17.63	<0.01

随着近视程度的增加,SE 屈光参差的比例增高,近视程度与 SE 屈光参差值有正相关关系($r=0.28$)($P<0.05$)。见图 2A~B。随着散光程度的增加,SE 屈光参差的比例增高,散光程度与 SE 屈光参差值有正相关关系($r=0.16$,$P<0.05$)。见图 2C~D。

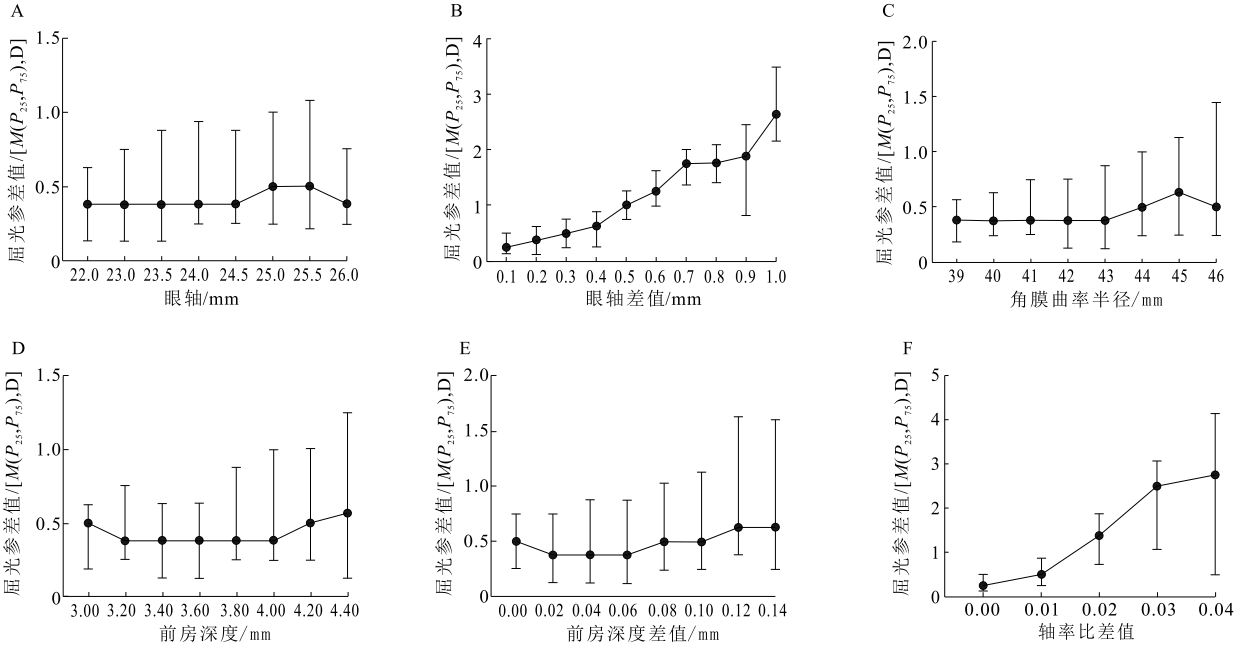


图 1　不同眼生物学参数屈光度组学龄儿童屈光参差程度

Figure 1　Degree of anisometropia among school-aged children based on different ocular biological parameters

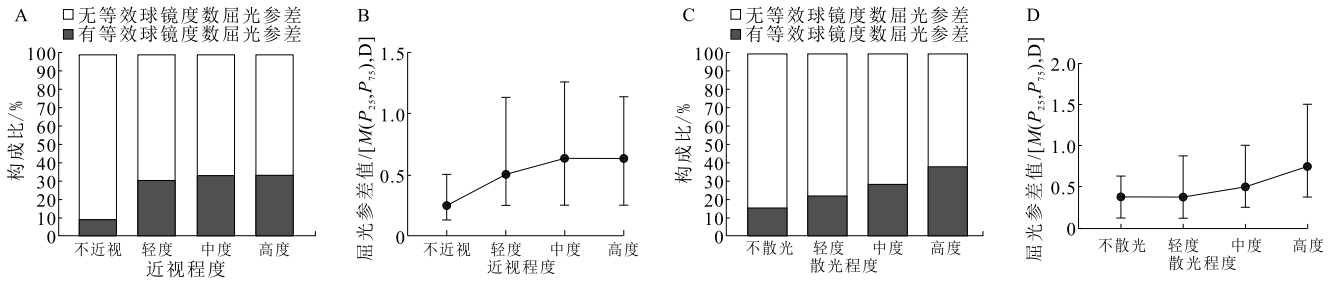


图 2　不同近视和散光程度学龄儿童屈光参差的比例和程度

Figure 2　Proportion and degree of anisometropia among school-aged children with different levels of myopia and astigmatism

2.6　学龄儿童 SE 屈光参差的二元 Logistic 回归分析　以是否 SE 屈光参差作为因变量(是=1,否=0),将单因素分析中有统计学意义的因素作为自变量纳入二元 Logistic 回归分析(Stepwise 法),结果显示,轻度近视(OR=2.74)、中度近视(OR=3.52)、高度近视(OR=8.92)的学龄儿童 SE 屈光参差的发生风险相对较高(P 值均<0.05)。见表 2。

表 2　学龄儿童等效球镜度数屈光参差相关因素 Logistic 回归分析(n=1 852)

Table 2　Logistic regression analysis of the related factors to SE anisometropia in school-aged children(n=1 852)

自变量	选项	β 值	标准误	$Wald\chi^2$ 值	P 值	OR 值(95%CI)
年龄/岁	7~9					1.00
	10~12	0.37	0.37	1.00	0.32	1.44(0.70~2.96)
	≥13	−0.40	0.33	1.51	0.22	0.67(0.35~1.27)
近视程度	不近视					1.00
	轻度	1.01	0.34	8.72	<0.01	2.74(1.40~5.35)
	中度	1.26	0.44	8.14	<0.01	3.52(1.48~8.36)
	高度	2.19	0.71	9.46	<0.01	8.92(2.21~35.98)
眼轴		−0.40	0.16	6.31	0.01	0.67(0.49~0.92)

3　讨论

本研究结果显示,学龄儿童屈光参差检出率较高(23.0%),高于葡萄牙(6.1%)[8]、中国山东(7.0%)[9],低于中国南通(25.6%)[11]的报道结果,提示该地区学龄儿童屈光参差防控迫在眉睫。研究中女生屈光参差检出率与男生差异无统计学意义,与国外报道一致[10]。10~12 岁年龄组屈光参差检出率(26.5%)高于≥13(25.9%)和 7~9 岁(13.7%)年龄组,初中生屈光参差检出率(26.3%)高于小学生(19.2%),相关研究表明屈光参差检出率有随着年龄和学段增长而增加的趋势[8-9, 17-18]。可能与随学龄增加,用眼负担加重、持续近距离用眼时间增多、不良久坐姿势、户外锻炼减少等危险因素的积累有关[19]。各民族间屈光参差检出率差异无统计学意义,原因可能是 SE 屈光参差的检出率更多是与眼睛的生长发育和用眼行为习惯有关。中度和高度近视的学龄儿童屈光参差检出率(33.3%)高于轻度近视(30.8%)和不近视(9.2%),与相关研究保持一致[20],提示近视是屈光参差的负性相关因素,且随着近视程度的加深,屈光参差的检出率也随之增加。

本研究中 SE 屈光参差的学龄儿童 SE、球镜和柱镜的屈光度均低于无屈光参差的学龄儿童,且随着近视程度的加深和柱镜屈光度的降低,SE 屈光参差的比例和屈光参差值均有增长趋势。提示近视和散光是屈光参差的危险因素,且近视程度影响屈光参差的严重程度。研究表明,屈光参差可在一定程度上作为衡量近视程度的指标[20]。近视和屈光参差的相互作用导致单侧近视进展,进而促进学龄儿童屈光不等[21-24]。有研究表明,散光可能与学龄儿童的屈光参差严重程度有关,散光可加速儿童近视化进展,双眼散光进展不等进而促进儿童的屈光参差[21]。因此,控制散光的发生可有效预防近视[25],进而控制屈光参差的发展。

本研究结果显示,在患有 SE 屈光参差的儿童中双眼 AL、CR、ACD 和双眼 AL、ACD 和 AL/CR 的差值均高于无 SE 屈光参差的儿童,且差异均有统计学意义。随着双眼 AL 和 AL 差值的增加,屈光参差严重程度均呈上升趋势。相关研究表明,AL 越长,屈光度越高[26]。双眼 AL 差异越大,屈光度差异也越大,屈光参差的程度也越大。与既往研究一致,由于 AL 生长幅度或速度的不对称是造成屈光参差的重要原因[27],进一步提示可通过 AL 长度的差值进行屈光参差预警及评估屈光参差程度。有研究表明,屈光参差的儿童屈光度更高眼 ACD 明显越大,屈光度越大[28]。ACD 在一定程度上影响双眼屈光度,双眼 ACD 的差异越大,屈光参差的严重程度越大,与本研究结果相吻合。相关研究表明,AL/CR 值能更敏感地预测学龄儿童的屈光增长趋势,AL/CR 值每增加 0.1 个单位,屈光度将增加 1.516 D[29]。提示双眼 AL/CR 的差异越大,双眼的屈光度差异也越大,屈光参差的严重程度越大。

Logistic 回归分析结果显示,SE 屈光参差与近视程度、AL 长度有关,提示可以根据不同人群的特性制定干预方案来降低屈光参差的发病率和严重程度,同时对 AL 较长和中高度近视的学龄儿童应加强屈光参差的监测。

本研究存在一定的局限性：由于调查是在学校中进行的，难以接受散瞳验光，屈光度检查是在非睫状肌麻痹下进行，导致晶状体变凸，出现假性近视或使真实度数被高估，可能会影响 SE 和部分眼球生物学参数测量结果的准确性；研究的样本量不够大，纳入调查的学生年级不连续，不能获取全学段屈光参差及眼生物学参数的数据，可能会导致一定的误差，未来调查应纳入更多学段；研究为是横断面数据，在一定程度上降低了研究价值，下一步将纳入随访数据更深层次探讨学龄儿童眼部生物学参数发育过程，为预防 SE 屈光参差提供参考。

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