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Social Anxiety Symptoms Across Myopia Status and Management Groups Among Adolescents: A Cross-Sectional Analysis

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Abstract

Purpose: To explore if myopia management strategies are associated with social anxiety symptoms among adolescents.

Methods: This was a cross-sectional analysis of baseline questionnaire data from a prospective adolescent cohort (aged 12-18 years) that collected information on different myopia management strategies (single-vision spectacles, orthokeratology, 0.01% atropine plus spectacles) and social anxiety. Social anxiety symptoms were assessed using the Social Anxiety Scale for Adolescents (SAS-A).

Results: A total of 1567 eligible adolescents were included in the analysis, with a mean (SD) age of 15.15 (1.92) years, and a mean (SD) SAS-A score of 30.74 (14.34). Of those, 829 (52.9%) were female. By myopia status and management strategy, 827 (52.8%) were non-myopic, 331 (21.1%) used single-vision spectacles, 232 (14.8%) Orthokeratology and 177 (11.3%) 0.01% atropine plus single-vision spectacles. After adjusting for prespecified covariables, myopia status and management strategy were significantly associated with SAS-A scores ($P < 0.001$). Compared with the non-myopic group, mean SAS-A scores were significantly higher in all 3 myopia management groups: single-vision spectacles (adjusted mean difference [aMD]=12.15, 95% CI, 10.77–13.54), Orthokeratology (aMD=20.77, 95% CI, 19.23–22.30), and 0.01% atropine plus single-vision spectacles (aMD=24.82, 95% CI, 23.10–26.54). Older age (p=0.013), lower maternal educational attainment (p=0.047), and lower household income (p=0.028) were also associated with a higher mean SAS-A score.

Conclusions: Adolescents using single-vision spectacles, orthokeratology, or 0.01% atropine plus spectacles were associated with higher social anxiety symptom scores than those in the non-myopic group. These findings highlight the relevance of psychosocial well-being in adolescent myopia care.

Keywords: myopia; adolescents; social anxiety; spectacles; orthokeratology; low-dose atropine

Introduction

Myopia is among the most common ocular conditions worldwide and can adversely affect vision-related quality of life [1,2]. An earlier age at onset is associated with a greater risk of high myopia in adulthood [3]. In children and adolescents, visual impairment and ocular disease have also been associated with anxiety, depression, and poorer mental health [4,5], adding to the overall burden of myopia for individuals and society [6]. Adolescence warrants particular attention because self-concept, concern about peer evaluation, and sensitivity to social influence continue to develop during this period [7,8].

Common myopia management strategies include spectacles, orthokeratology, and low-dose atropine used with spectacles [6]. Spectacles are accessible and convenient but have limited effects on slowing myopia progression. Orthokeratology lenses temporarily reshape the cornea during overnight wear, provide clear daytime vision, and can reduce axial elongation [9]. However, they require appropriate lens care and may be associated with corneal complications [10]. Studies of low-dose atropine have reported differing effects on myopia progression; photophobia, pupil dilation, and accommodation-related symptoms remain relevant safety considerations [11–13].

Previous studies of myopia management have focused primarily on optical efficacy, ocular safety, and vision-related quality of life [1,14–19]. Much less is known about whether social anxiety symptoms differ among adolescents using common management strategies. This question is particularly relevant during adolescence, when concerns about appearance and peer evaluation become more salient [20]. Myopia management strategies also differ in visibility, daily care requirements, and the degree of family involvement they entail. We therefore used baseline data from a prospective cohort to compare SAS-A scores across three myopia management groups, with adolescents without self-reported myopia serving as the reference group. The analysis aimed to characterize the cross-sectional associations of myopia status and management strategy with social anxiety symptoms at cohort entry.

Methods

1. Participants

Adolescents aged 12–18 years were prospectively recruited. They included adolescents with myopia who were using different management strategies and adolescents who reported no myopia and no myopia-related correction or intervention, who served as a background

reference group. All study procedures complied with the Declaration of Helsinki and were approved by the Ethics Committee of Guangzhou Medical University (approval no. ES-2025-233-01).

Participants with myopia were eligible if they (1) were aged 12–18 years; (2) had previously received a physician diagnosis of myopia with a spherical equivalent of ≤−0.50 D and were currently using single-vision spectacles, orthokeratology, or 0.01% low-dose atropine plus spectacles; (3) reported a spherical equivalent of −0.50 to −6.00 D, cylinder of ≤1.50 D, and interocular refractive difference of <1.50 D in the questionnaire; (4) reported monocular best-corrected visual acuity of ≥5.0; (5) had no ocular disease other than refractive error and no history of ocular surgery or trauma; (6) had no systemic disease that could affect visual function; and (7) reported no mental disorder. Participants in the non-myopic reference group were aged 12–18 years and self-reported no myopia and no myopia-related correction or intervention; this classification was not confirmed by standardized objective refraction. Exclusion criteria were inability to communicate effectively, refusal or withdrawal of consent, parental refusal, and failure to meet the prespecified data-completeness requirements.

Questionnaire data were collected through three recruitment channels: school-based recruitment at a secondary school in Changsha, clinic-based recruitment at the First Affiliated Hospital of Guangzhou Medical University, and online recruitment of first-year university students. The questionnaire recorded age, sex, monthly household income, place of residence, parental educational attainment, and single-parent household status. Myopia status, refractive category, best-corrected visual acuity, age at myopia onset, duration of myopia, and current management strategy were recorded from participants' self-reported questionnaire responses.

2. Assessment of social anxiety

Social anxiety symptoms were assessed using the simplified Chinese version of the Social Anxiety Scale for Adolescents (SAS-A) [21,22]. The original 18-item SAS-A was developed by La Greca and Lopez [22]; the validated simplified Chinese version contains 12 items [21] across three subscales: Fear of Negative Evaluation (FNE), Social Avoidance and Distress in New Situations (SAD-New), and General Social Avoidance and Distress (SAD-General). Each item is scored on a 5-point Likert scale, yielding a total score of 12–60, with higher scores indicating greater symptom severity.

3. Classification of myopia management strategies

Each participant with myopia was classified according to the primary correction or management strategy used at the time of the survey: single-vision spectacles, orthokeratology, or 0.01% atropine plus single-vision spectacles. Participants reported that they had used the same strategy continuously for at least 12 months without changing correction type. Adolescents who self-reported no myopia and no myopia-related correction or intervention comprised the non-myopic reference group (Table 1).

Table 1. Analysis groups and current myopia management characteristics

Group	Current management strategy	Mechanism	Use regimen
Non-myopic reference group	No myopia-related correction or intervention (self-reported)	Not applicable	Not applicable
Single-vision spectacles group	Single-vision spectacles	Concave lenses alter refraction so that light focuses on the retina [6].	Worn daily during waking hours
Orthokeratology group	Rigid gas-permeable corneal contact lenses	Temporarily reshapes the cornea overnight, flattening the central cornea [9].	Worn during sleep and removed during the day
0.01% atropine plus single-vision spectacles group	Low-dose atropine eye drops plus spectacles	May slow axial elongation through pathways involving scleral signaling [11–13].	Administered once nightly

Note: These descriptions define the analysis groups and should not be interpreted as evidence that a management strategy reduces or increases social anxiety symptoms.

4. Statistical analysis

Participant characteristics were summarized descriptively. Continuous variables were presented as means with standard deviations (SD), and categorical variables as numbers with percentages (%). Univariate linear regressions were used to explore the association between SAS-A score and each prespecified covariable. Multivariable linear regression was used to

explore the adjusted association between SAS-A score and myopia status and myopia management strategy, adjusting for prespecified age, sex, educational stage, maternal and paternal educational attainment, monthly household income, and single-parent household status. Adjusted mean differences (aMDs) and 95% confidence intervals (95%CIs) were reported. Age and household income were treated as continuous variables.

In addition, we explored the associations of 3 SAS-A subscales (FNE, SAD-New, and SAD-General) with myopia status and myopia management strategy in multivariable regression models. Full-sample subscale models additionally adjusted for place of residence. All analyses were performed using IBM SPSS Statistics version 27.0. Tests were two-sided, with $P < 0.05$ considered statistically significant.

Results

A total of 2,121 participants were surveyed using questionnaires. Of those, 554 participants who did not meet the eligibility criteria or had incomplete data were excluded. The remaining 1,567 participants with valid baseline records were included in the analysis, with a mean (SD) age of 15.15 (1.92) years, and a mean (SD) SAS-A score of 30.74 (14.34). Of those, 829 (52.9%) were female. By myopia status and management strategy, 827 (52.8%) were non-myopic, 331 (21.1%) used single-vision spectacles, 232 (14.8%) Orthokeratology and 177 (11.3%) 0.01% atropine plus single-vision spectacles.

Univariate factors associated with total SAS-A score

As shown in Table 2, mean total SAS-A scores differed significantly across the four myopia status and management strategy groups ($P < 0.001$). The mean (SD) scores were 22.39 (6.85) in the non-myopic group, 33.80 (14.50) in single-vision spectacles, 43.33 (13.96) in orthokeratology, and 47.55 (11.01) in 0.01% atropine plus single-vision spectacles groups. Total SAS-A score showed a positive association with age ($P = 0.001$). No statistically significant associations were observed for sex, educational stage, Maternal educational attainment, paternal educational attainment, monthly household income, or single-parent household status (Table 2).

Table 2. Participant characteristics and univariable comparisons of total SAS-A scores (N = 1,567)

Characteristic	n (%)	Total SAS-A score, mean ± SD	P value

Characteristic	n (%)	Total SAS-A score, mean ± SD	P value
Age, mean (SD)	15.15±1.92	30.74±14.34	0.001
Myopia management strategy, n (%)			<0.001
Non-myopic reference group	827 (52.8)	22.39±6.85	
Single-vision spectacles	331 (21.1)	33.80±14.50	
Orthokeratology	232 (14.8)	43.33±13.96	
0.01% atropine plus single-vision spectacles	177 (11.3)	47.55±11.01	
Sex, n (%)			0.065
Male	738 (47.1)	30.03±14.33	
Female	829 (52.9)	31.37±14.34	
Educational stage, n (%)			0.122
Junior secondary school (12–14 years)	752 (48.0)	30.16±13.97	
Senior secondary school (15–18 years)	815 (52.0)	31.28±14.67	
Maternal educational attainment, n (%)			0.070
High school or technical secondary school and below	588 (37.5)	31.60±14.63	
College or university and above	979 (62.5)	30.23±14.15	
Paternal educational attainment, n (%)			0.243
High school or technical secondary school and below	582 (37.1)	31.30±14.56	
College or university and above	985 (62.9)	30.41±14.21	
Monthly household income (CNY), n (%)			0.093
<5,000	452 (28.8)	31.45±14.63	
5,000–10,000	749 (47.8)	30.99±14.46	
>10,000	366 (23.4)	29.36±13.69	
Single-parent household, n (%)			0.353
Yes	198 (12.6)	31.63±14.53	
No	1,369 (87.4)	30.61±14.32	

Multivariable factors associated with total SAS-A score

As shown in Table 3 and Figure 1, after adjusting for prespecified covariables, myopia status and management strategy were significantly associated with mean total SAS-A scores ($P < 0.001$). Compared with the non-myopic group, mean SAS-A scores were higher in all 3 myopia management groups: single-vision spectacles (aMD=12.15, 95% CI, 10.77–13.54), Orthokeratology (aMD=20.77, 95% CI, 19.23–22.30), and 0.01% atropine plus single-vision spectacles (aMD=24.82, 95% CI, 23.10–26.54). In addition, each 1-year increase in age was significantly associated with a higher mean total SAS-A score (aMD=0.657, 95%CI=0.140–1.175; P = 0.013). Maternal education at college level or above was associated with a lower SAS-A score (aMD=-1.110, 95%CI=−2.207 - −0.013; P = 0.047), and each one-category increase in household income was associated with a lower mean SAS-A score (aMD=-0.838, 95% CI= −1.583 to −0.093; P = 0.028). Sex, educational stage, paternal educational attainment, and single-parent household status were not significantly associated with total SAS-A score.

Table 3. Multivariable linear regression of total SAS-A score in the full sample (N = 1,567)

Characteristic	Adjusted mean difference (MD)	95% CI of MD	P value
Age	0.657	0.140–1.175	0.013
Educational stage			
Junior secondary school (12–14 years)	−1.417	−3.348–0.515	0.150
Senior secondary school (15–18 years)	0.000 (reference)	—	—
Sex			
Male	0.000 (reference)	—	—
Female	0.627	−0.418–1.672	0.240
Maternal educational attainment			
High school or technical secondary school and below	0.000 (reference)	—	—
College or university and above	−1.110	−2.207–−0.013	0.047
Paternal educational attainment			
High school or technical secondary school and below	0.000 (reference)	—	—
College or university and above	−0.624	−1.720–0.473	0.265
Monthly household income (per category increase)	−0.838	−1.583–−0.093	0.028
Single-parent household			
Yes	0.000 (reference)	—	—
No	−0.694	−2.266–0.877	0.386
Myopia status and management strategy			
Non-myopic reference group	0.000 (Reference)	-	-
Single-vision spectacles	12.152	10.767–13.536	<0.001
Orthokeratology	20.766	19.231–22.301	<0.001
0.01% atropine plus single-vision spectacles	24.822	23.104–26.540	<0.001

Note: MD, adjusted mean difference; CI, confidence interval; SAS-A, Social Anxiety Scale for Adolescents. The reported model includes age, educational stage, sex, maternal and paternal educational attainment, monthly household income, single-parent household status, and myopia status and management strategy. The age coefficient is expressed per 1-year increase; the income coefficient is expressed per category increase, as labeled in the table. Reference entries identify the reference category for each categorical predictor.

（Figure 1）

Figure 1. Adjusted mean differences in total SAS-A score for the three myopia management groups relative to the non-myopic reference group. Points indicate adjusted mean differences, and horizontal lines indicate 95% CIs. The non-myopic reference group has no confidence interval; model covariates are listed in Table 3.

SAS-A subscale analyses

To further examine the associations between different domains of social anxiety symptoms and myopia status and management strategy, the three SAS-A subscales (FNE, SAD-New, and SAD-General) were analyzed separately. In the available dataset (N = 1,567), adjusted mean differences in FNE, SAD-New, and SAD-General were positive for each of the three myopia management groups versus the non-myopic reference group (all nine contrasts, $P < 0.001$; Table 4). The overall adjusted group test was significant for each subscale (all three tests, $P < 0.001$).

Table 4. Adjusted mean differences in SAS-A subscale scores in the full sample (N = 1,567)

Group	Observed subscale, mean (SD)	Adjusted MD (95%CI), p value	Overall group test (Type 3)
FNE			P < 0.001
Non-myopic reference group	7.54 (2.92)	0.00 (reference)	
Single-vision spectacles	11.22 (5.46)	3.89 (3.37–4.42) P < 0.001	
Orthokeratology	14.37 (4.93)	6.77 (6.19–7.35) P < 0.001	
0.01% atropine plus single-vision spectacles	15.81 (3.84)	8.17 (7.51–8.82) P < 0.001	
SAD-New			P < 0.001
Non-myopic reference group	7.62 (2.82)	0.00 (Reference)	
Single-vision spectacles	11.90 (5.16)	4.44 (3.93–4.95) P < 0.001	
Orthokeratology	14.55 (4.72)	6.89 (6.33–7.46) P < 0.001	
0.01% atropine plus single-vision spectacles	15.72 (3.99)	8.05 (7.42–8.68) P < 0.001	

Group	Observed subscale, mean (SD)	Adjusted MD (95%CI), p value	Overall group test (Type 3)
SAD-General			P < 0.001
Non-myopic reference group	7.23 (2.34)	0.00 (Reference)	
Single-vision spectacles	10.68 (5.15)	3.83 (3.35–4.31) P < 0.001	
Orthokeratology	14.41 (4.84)	7.10 (6.57–7.63) P < 0.001	
0.01% atropine plus single-vision spectacles	16.02 (3.67)	8.60 (8.01–9.19) P < 0.001	

Note: Observed values are mean (SD). Adjusted mean differences (MDs) compare each management group with the non-myopic reference group. Models followed the covariate structure and reference categories described for Table 3, with age entered per year and income per one-category increase. Confidence intervals (CIs) and two-sided P values use conventional OLS inference; overall group tests are Type III-equivalent partial F tests (3, 1,556 df).

FNE, Fear of Negative Evaluation; SAD-New, Social Avoidance and Distress in New Situations; SAD-General, General Social Avoidance and Distress.

Discussion

This cross-sectional analysis of a prospective cohort examined social anxiety symptoms in 1,567 adolescents, comparing those receiving single-vision spectacles, orthokeratology, or 0.01% atropine plus single-vision spectacles with a non-myopic reference group. Mean total SAS-A scores were lowest in the non-myopic reference group, followed by the single-vision spectacles, orthokeratology, and 0.01% atropine plus single-vision spectacles groups. Scores in each of the three myopia management groups remained higher than those in the reference group after adjustment for demographic and family factors. Older age was associated with higher total SAS-A scores, whereas higher maternal educational attainment and household income were associated with lower scores. These findings describe associations at cohort baseline and do not establish causal effects of myopia management on social anxiety symptoms.

Associations between management strategy and social anxiety symptoms

Differences in myopia status, treatment selection, and daily management requirements may help explain the observed associations with social anxiety symptoms. Management strategies differ in visibility, lens-care requirements, daily eye-drop administration, and family supervision [10–20,23,24]. Perceived appearance, care burden, adherence, parental supervision, and adverse effects were not measured directly, so their contributions remain uncertain.

Substantial confounding by indication may exist across the management groups. Adolescents with earlier-onset myopia, longer disease duration, or a higher risk of progression may be more likely to receive orthokeratology or atropine combination therapy [3,25]. Incomplete information on recruitment sources and the absence of source adjustment leave the estimates vulnerable to selection bias and source-related confounding.

Adjusted mean differences versus the non-myopic reference group were positive across FNE, SAD-New, and SAD-General in all three myopia management groups. Without comparisons of standardized effects or tests of group-by-subscale interactions, the results do not show whether the association was stronger for one SAS-A subscale than another.

Age and socioeconomic status

Older age was associated with a higher total SAS-A score, whereas higher household income and maternal educational attainment were associated with lower scores. These findings may reflect differences across age groups and family socioeconomic circumstances at cohort baseline [7,8,26–32]; they do not indicate that scores increased year by year within the same individual. The non-significant coefficient for paternal educational attainment does not establish an absence of association. Economic strain, parent–child interactions, and division of caregiving responsibilities were not measured, and the underlying family mechanisms require further study.

Clinical implications

Existing ophthalmic regimens should not be changed on the basis of SAS-A scores from this study. During clinical follow-up, attention to adolescents' psychosocial adjustment, treatment burden, and family support may be useful. Management strategies should continue to be selected according to ophthalmic indications, risk of myopia progression, safety, and individual preferences.

Limitations

These findings should be interpreted in the context of the study design. As this was an observational analysis of cohort baseline data, the results describe associations rather than causal effects. Although the models accounted for key measured covariates, differences related to recruitment setting and management-group characteristics may not have been fully captured, and ocular information was primarily self-reported. Further longitudinal studies incorporating objective ophthalmic assessments and broader recruitment will help confirm the robustness and generalizability of these findings.

Conclusion

Social anxiety symptoms differed across the four study groups, with higher total and subscale SAS-A scores among adolescents using single-vision spectacles, orthokeratology, or 0.01% atropine plus spectacles than in the non-myopic reference group. Older age was associated with higher SAS-A scores, whereas higher maternal educational attainment and household income were associated with lower scores. These findings extend the evaluation of adolescent myopia beyond visual outcomes and highlight the value of considering psychosocial well-being in routine care. Continued follow-up of this cohort may help clarify changes in social anxiety over time and support more individualized myopia management.

Declarations

Abbreviations

aMD: adjusted mean difference; CI: confidence interval; CNY: Chinese yuan; D: dioptre; df: degrees of freedom; FNE: Fear of Negative Evaluation; MD: adjusted mean difference; OLS: ordinary least squares; SAD-General: General Social Avoidance and Distress; SAD-New: Social Avoidance and Distress in New Situations; SAS-A: Social Anxiety Scale for Adolescents; SD: standard deviation; SPSS: Statistical Package for the Social Sciences.

Ethics approval and consent to participate

All study procedures complied with the Declaration of Helsinki and were approved by the Ethics Committee of Guangzhou Medical University (approval no. ES-2025-233-01). Informed consent to participate was obtained from all participants and their parents or legal guardians before questionnaire completion. This included parental or legal guardian consent for all participants under 16 years of age. Participants could begin completing the questionnaire only after both they and their parents or legal guardians had agreed to participate.

Consent for publication

Not applicable.

Availability of data and materials

To protect the privacy of participating adolescents, the datasets analyzed during the current study are not publicly available for download. However, the data can be obtained from the corresponding authors upon reasonable request, with all participant names replaced by de-identified codes prior to provision.

Competing Interests

The authors declare no competing interests.

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Authors' contributions

XL and DC conceptualized the study, and XL, JC, and DC developed the methodology, with JC responsible for software. XL, JC, WR, JH, HC, and DC curated the data, while XL, HL, WR, MH, ZL, RX, JH, HC, and DC conducted the investigation. HL, JC, MH, ZL, RX, HC, and DC validated the study; XL, JC, HC, and DC performed the formal analysis; and XL, JC, and DC prepared the visualizations. XL, HL, RX, JH, HC, and DC supervised the research, RX, HC, and DC administered the project, HL, ZL, JH, HC, and DC provided resources, and DC acquired the funding. XL, ZL, and DC drafted the manuscript, and XL, HL, MH, ZL, RX, and DC reviewed and edited it. All authors reviewed and approved the final manuscript.

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Declaration of generative AI and AI-assisted technologies in manuscript preparation

During preparation of this manuscript, the authors used OpenAI Codex for language editing, structural organization, and review of statistical reporting. The authors subsequently reviewed and edited the content and take full responsibility for the manuscript.

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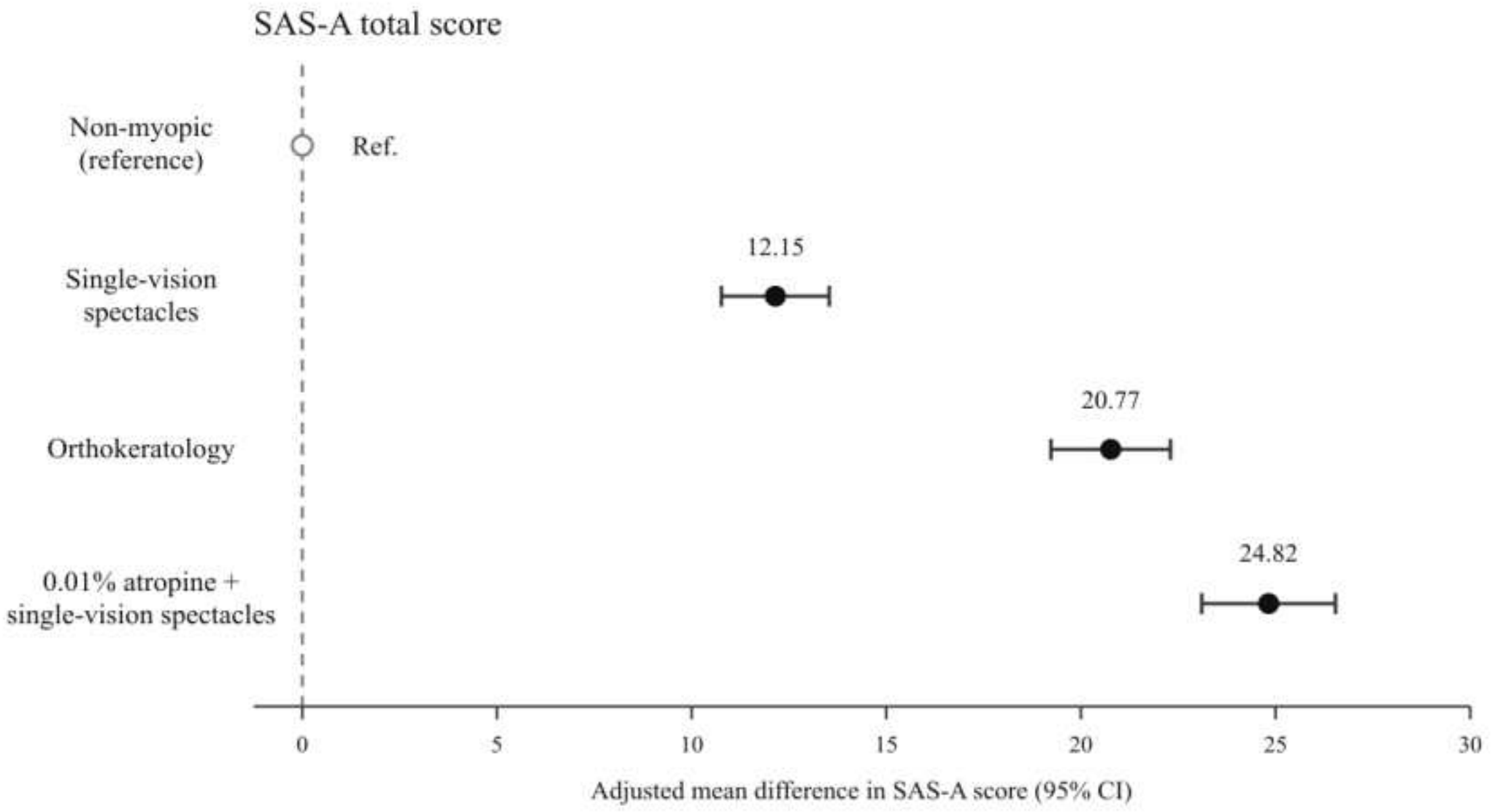
SAS-A total score
Non-myopic (reference)
Ref.
Single-vision spectacles
12.15
Orthokeratology
20.77
0.01% atropine + single-vision spectacles
24.82
0
5
10
15
20
25
30
Adjusted mean difference in SAS-A score (95% CI)