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Is Refractive Error Associated with Body Mass Index?

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ABSTRACT

Background: Refractive errors are a leading cause of visual impairment, and both myopia prevalence and obesity rates are increasing globally. Emerging literature suggests that body mass index (BMI) may be associated with refractive outcomes, but findings remain inconsistent. Objective: To synthesize evidence on the association between BMI and refractive errors, including myopia, astigmatism, and hyperopia/hyperopic reserve. Methods: A narrative review was conducted using PubMed/MEDLINE, Google Scholar, Scopus, and Web of Science to identify peer-reviewed observational studies published within the last ten years examining BMI and refractive outcomes. Keywords included body mass index, obesity, overweight, myopia, astigmatism, hyperopia, and refractive error. Findings were synthesized narratively due to heterogeneity in populations and outcome definitions. Results: The reviewed evidence, predominantly cross-sectional, most consistently linked BMI with myopia, including nonlinear (J-shaped or inverse L-shaped) patterns in large adolescent datasets. Associations appeared stronger for high myopia than for mild-to-moderate myopia in several populations. Astigmatism was also positively associated with higher BMI in adolescents and was supported by maternal BMI associations with offspring corneal curvature. Evidence for hyperopia prevalence was limited; however, higher BMI was associated with suspected insufficient hyperopic reserve in preschool children. Conclusion: Current evidence suggests that BMI is associated with myopia and astigmatism, while evidence for hyperopia remains inconclusive. Longitudinal studies with standardized refraction assessment and precise adiposity measures are required to clarify temporal relationships and biological mechanisms.

Keywords
Body mass index; obesity; myopia; astigmatism; hyperopia reserve; refractive error.

INTRODUCTION

Refractive errors (REs), including myopia, hyperopia, and astigmatism, represent one of the most prevalent ocular conditions worldwide and constitute a major, preventable cause of visual impairment when left uncorrected. The inability of the optical system of the eye to focus light precisely on the retina leads to blurred vision that can adversely affect educational performance, occupational productivity, and overall quality of life across the lifespan. Population-level analyses have consistently shown that uncorrected refractive error contributes substantially to global vision loss and remains a key public health priority due to its high burden and the availability of effective corrective strategies. In addition to the direct functional limitations imposed by reduced visual acuity, refractive errors—particularly myopia—are increasingly recognized as risk factors for future ocular morbidity, including retinal detachment, myopic maculopathy, and glaucoma, especially when myopia progresses to high myopia. These implications underscore the importance of identifying modifiable determinants of refractive error development and progression in susceptible populations such as children and adolescents (2,5).

Among the refractive errors, myopia has emerged as the most rapidly increasing condition worldwide, with marked growth in prevalence documented over recent decades. Projections suggest that by 2050, approximately half of the world's population may be affected by myopia, with a substantial proportion developing high myopia, thereby increasing the future burden of sight-threatening complications (5). The rise in myopia has coincided with global lifestyle transformations driven by urbanization, increased educational demands, prolonged near work, and reduced time spent outdoors. These behavioral and environmental shifts have been repeatedly implicated in myopia epidemiology, yet they often coexist with broader metabolic and anthropometric changes occurring worldwide. One of the most prominent parallel trends is the rising prevalence of overweight and obesity, which now affects children, adolescents, and adults across both high-income and low- and middle-income settings. Excess adiposity, often indexed by body mass index (BMI), is strongly associated with chronic diseases such as cardiovascular disease, diabetes, and stroke, and it has also been linked to an expanding range of ocular pathologies including diabetic retinopathy, cataract, and potentially refractive development abnormalities (3).

BMI is a widely used anthropometric indicator calculated as body weight divided by height squared. It is practical, inexpensive, and routinely used in clinical and epidemiological studies as a surrogate for body fat (9). However, BMI has well-recognized limitations: it does not differentiate between fat mass and lean mass and may not accurately represent adiposity during periods of rapid growth in childhood or adolescence. Alternative indices such as waist measures, body fat percentage, and specialized adiposity indices may offer improved estimation of metabolic risk but are not consistently measured across large population-based studies (9,10). Despite these limitations, BMI remains the most frequently available anthropometric measure in large cohorts and national health datasets, making it a convenient candidate for investigating possible relationships between body composition and ocular outcomes. Importantly, obesity and refractive error may coexist through overlapping determinants such as sedentary behavior, reduced outdoor activity, prolonged screen exposure, dietary patterns, and socioeconomic factors, raising the possibility that BMI could correlate with refractive status either through direct biological pathways, indirect behavioral mediation, or confounding by shared exposures (13,22).

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Multiple observational studies have examined whether BMI is associated with myopia or other refractive errors, but the findings remain inconsistent. Some studies suggest that overweight and obesity are linked with higher odds of myopia, with nonlinear associations reported in large datasets, including inverse L-shaped and J-shaped patterns in children and adolescents. For example, studies in Chinese schoolchildren and adolescents have described a rising risk of myopia across increasing BMI ranges up to a certain threshold, followed by plateauing or curvature of the relationship, indicating that both underweight and obesity may influence refractive patterns in different ways (12,15). In contrast, analyses using alternative anthropometric indices such as the weight-adjusted waist index have reported inverse or protective associations with myopia in certain populations, suggesting heterogeneity based on measurement choice, age group, metabolic phenotype, or residual confounding (14). Other investigations have proposed that metabolic indices integrating triglyceride-glucose markers with BMI may be associated with myopia, implying that metabolic dysregulation could represent a biologically plausible link between adiposity and ocular growth (23). However, many available studies are cross-sectional, limiting causal inference and raising the possibility of reverse causation—where children with myopia engage in more indoor and near work activities, spend less time outdoors, and consequently display higher BMI.

Beyond myopia, a smaller body of evidence suggests possible associations between BMI and astigmatism, including findings that increased BMI is linked to higher prevalence and severity of astigmatism in adolescents. Some studies have extended this association into prenatal exposures, showing that maternal pre-pregnancy overweight and obesity may influence corneal curvature and astigmatism in offspring, suggesting early developmental influences on corneal biomechanics (17). Conversely, hyperopia has been less consistently linked to BMI. Recent pediatric work has focused not only on hyperopia prevalence but also on the concept of "hyperopic reserve" in preschool children, which refers to the physiological hyperopia expected during early childhood that gradually reduces with ocular growth. Insufficient hyperopic reserve has been proposed as a predictor of future myopia onset, and emerging data suggest that higher BMI may be associated with reduced hyperopic reserve, though evidence remains limited and requires further validation (18).

Biological mechanisms linking BMI to refractive error have been hypothesized but remain incompletely established. It has been suggested that obesity-related metabolic disturbances, including hyperinsulinemia and alterations in insulin-like growth factor signaling, could influence scleral remodeling and axial elongation, thereby contributing to myopia development. Chronic low-grade inflammation associated with excess adiposity may also affect ocular tissues and growth regulation. Additionally, dopamine-mediated retinal signaling, which is influenced by light exposure and implicated in immortalization, may be indirectly affected through behavioral pathways such as reduced outdoor activity among overweight children. However, these mechanistic pathways remain largely theoretical and should be interpreted cautiously due to the limited availability of direct experimental evidence supporting causal biological effects (3,23).

Given the growing global prevalence of both obesity and refractive error—particularly childhood myopia—and the potential overlap in modifiable lifestyle determinants, clarifying whether BMI is associated with refractive error is clinically and public health relevant. If BMI is related to refractive patterns, it may represent either a marker of shared behavioral risks or a potential modifiable contributor to ocular growth abnormalities. Understanding these associations could help integrate vision-health strategies with broader child health interventions focused on physical activity and lifestyle optimization. Therefore, this narrative review aims to synthesize available evidence from the past decade regarding the association between BMI and refractive errors, with a primary focus on myopia and additional evaluation of astigmatism and hyperopia or hyperopic reserve. The review also explores key confounding and mediating factors, including age, height and ocular biometry, parental myopia, screen time and near work, outdoor exposure, and metabolic indicators, to contextualize observed associations and highlight areas requiring longitudinal and mechanistic research (12–15,17–23).

MATERIALS AND METHODS

This narrative review was conducted to synthesize evidence on the association between body mass index (BMI) and refractive errors, including myopia, hyperopia, astigmatism, and related constructs such as hyperopic reserve. A narrative review approach was chosen because available evidence is heterogeneous in terms of study populations, refractive error definitions, anthropometric indices, and adjustment for confounding, and because the aim was to provide an integrative understanding of trends, inconsistencies, and possible explanatory mechanisms rather than to generate a pooled quantitative estimate. The review focused on literature published within the last ten years to ensure relevance to contemporary lifestyle patterns and rising global prevalence trends in both obesity and refractive errors.

A structured literature search was performed using electronic databases including PubMed/MEDLINE, Google Scholar, Scopus, and Web of Science. Search was conducted using combinations of controlled and free-text keywords related to anthropometric measures and refractive outcomes. The core search terms included "body mass index," "BMI," "obesity," "overweight," "adiposity," "myopia," "hyperopia," "astigmatism," "refractive error," and "ocular biometrics." Database search strategies were adapted to each platform. For PubMed/MEDLINE, the following representative search string was applied: ("body mass index" OR BMI OR obesity OR overweight OR adiposity) AND (myopia OR hyperopia OR astigmatism OR "refractive error" OR refraction). Additional terms were incorporated to capture mechanistic and biometric outcomes, including "axial length," "ocular biometry," "corneal curvature," "hyperopic reserve," and "metabolic syndrome," when necessary. Reference lists of eligible articles and relevant review papers were also screened to identify additional studies that may not have been captured through electronic searching.

Studies were considered eligible if they met the following criteria: (i) original research articles published in peer-reviewed journals; (ii) observational designs including cross-sectional studies, cohort studies, and population-based health survey analyses; (iii) participants from pediatric, adolescent, or adult populations; (iv) reported BMI or a BMI-derived index as an exposure variable; and (v) assessed refractive outcomes measured by objective refraction, cycloplegic refraction where applicable, or standardized ophthalmic assessment methods. Studies focusing exclusively on ocular diseases not relevant to refractive status (e.g., diabetic retinopathy without refractive assessment) were excluded. Non-human studies, case reports, editorials, and conference abstracts without full text were excluded. Studies were primarily restricted to English-language publications due to feasibility constraints; however, where accessible, key regional studies relevant to pediatric hyperopic reserve were also considered. The review prioritized studies published between 2015 and 2025, aligning with the intended recency window.

Article selection was performed by first screening titles and abstracts for relevance to the research objective. Full texts were then reviewed for eligibility. Because this was a narrative review, formal duplicate independent screening and inter-rater agreement statistics were not employed; however, study inclusion was guided by pre-defined inclusion boundaries and relevance to the core research question. After selection, key

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information was extracted into a standardized evidence summary format including: author/year, country and setting, study design, sample size and age range, BMI definition and categorization, refractive error definitions (including threshold cut-offs for myopia and high myopia where provided), outcome measurement methods, covariates included in adjusted models, and key findings including direction and strength of association. When studies reported nonlinear associations (e.g., J-shaped or inverse L-shaped), these were recorded along with the stated BMI thresholds. Studies exploring related anthropometric indicators (e.g., weight-adjusted waist index, body fat percentage) or metabolic composite indices (e.g., triglyceride–glucose BMI) were included when they contributed to understanding biological plausibility or explained inconsistencies in BMI-only findings.

Due to heterogeneity in study designs, populations, refractive error thresholds, and statistical measures used across studies, no quantitative meta-analysis was performed. Instead, findings were synthesized narratively by refractive outcome category (myopia/high myopia, astigmatism, hyperopia/hyperopic reserve), and emphasis was placed on identifying consistent trends, contradictory findings, and potential sources of heterogeneity. Particular attention was given to confounding and mediation by shared determinants, including age, height and general growth patterns, parental myopia, physical activity, outdoor exposure, screen time and near work, urban residence, and socioeconomic status. Where studies reported ocular biometric correlates (axial length, chamber depths, corneal curvature), these were included as intermediary phenotypes linking anthropometry with refractive status. The strength and limitations of evidence were interpreted in light of the predominance of cross-sectional designs and potential residual confounding.

Because this study was based exclusively on published literature and did not involve collection of primary human data, institutional ethical approval was not required. The authors report no conflicts of interest relevant to this review, and no external funding was received. The evidence synthesis and interpretation were conducted with the intent to inform clinicians, educators, and public health stakeholders regarding the potential relevance of weight status and metabolic health in refractive development, and to highlight priorities for future longitudinal and mechanistic research in this evolving field.

RESULTS

Across the eligible studies reviewed, the evidence base consisted predominantly of cross-sectional observational designs conducted in school-aged children, adolescents, and young adults, with a smaller number of nationwide datasets and health survey analyses. Most studies defined BMI using standard weight/height^2 criteria and categorized participants into underweight, normal weight, overweight, and obese groups, whereas some studies evaluated alternative adiposity indices or metabolic composites integrating BMI. Refractive outcomes were most often expressed as myopia prevalence or odds, with fewer studies focusing on high myopia, astigmatism subtypes, or hyperopia reserve in preschool children. Overall, the reviewed literature indicated that myopia was the refractive error most consistently associated with BMI, with the relationship frequently described as nonlinear. Several large population-based studies suggested that both low and high BMI could be associated with higher odds of myopia, consistent with J-shaped or inverse L-shaped patterns reported particularly in East Asian schoolchildren and adolescents. In contrast, results derived from alternative anthropometric indices occasionally suggested inverse associations with myopia, highlighting potential measurement dependency and heterogeneity between populations and analytic approaches (11–15).

A set of studies demonstrated that growth-related anthropometric indicators—especially height and body weight—were strongly associated with ocular biometric parameters such as axial length, anterior chamber depth, and vitreous chamber depth, and these biometric changes were aligned with refractive shifts toward myopia. In one ocular biometry study, taller stature was associated with longer axial length and deeper ocular chambers, while higher BMI was associated with a tendency toward more hyperopic refractions, emphasizing that BMI and height may capture different growth-related contributions to ocular development (16). In a schoolchild dataset, height was reported as the strongest predictor of ocular biometric change even after adjustment for major confounders, with taller children showing longer axial lengths and more myopic refractions. Higher body weight was also associated with longer axial length and greater myopic shifts, and these associations were consistent across age strata, supporting the concept that ocular growth may be coordinated with general somatic growth in early school years (21).

Evidence linking BMI to high myopia appeared more specific and potentially stronger than associations with mild to moderate myopia. In Korean national survey data, childhood and adolescent obesity was reported to be associated with high myopia, with sex-specific patterns observed—obese boys and overweight/obese girls showing higher risk of severe refractive error in stratified analyses (19). Similarly, an analysis of Korean children indicated that age and parental myopia were strong contributors to both myopia and high myopia, and increased BMI was not consistently related to general myopia but showed stronger association with high myopia, suggesting that weight status may be more relevant to severe refractive phenotypes rather than early or mild refractive shifts (22). A large nationwide adolescent dataset also supported a nonlinear BMI–myopia association and identified differential risks across BMI extremes, particularly among males (13,19).

Several studies expanded beyond BMI alone to evaluate adiposity-related metabolic indicators, which may represent a more biologically relevant exposure than anthropometric size measures alone. Notably, a study assessing triglyceride-glucose–body mass index (TyG-BMI) reported that adolescents in the highest TyG-BMI category had 20% greater odds of myopia compared with those in the lowest category (OR = 1.20; 95% CI: 1.0–1.5; $p < 0.05$), supporting the hypothesis that metabolic dysregulation may contribute to refractive risk beyond simple body size (23). Conversely, an analysis using the weight-adjusted waist index (WWI) suggested reduced odds of myopia in higher WWI tertiles, indicating that different anthropometric indices may capture distinct physiological constructs and that the direction of association may vary depending on whether adiposity distribution, metabolic risk, or body proportionality is emphasized (14).

Regarding astigmatism, reviewed studies suggested a consistent relationship between increased BMI and astigmatism prevalence or severity. A nationwide adolescent study reported that rising BMI was associated with increased risk and severity of astigmatism, with the strongest association observed for with-the-rule astigmatism. Complementing this evidence, maternal pre-pregnancy overweight and obesity were linked to greater corneal curvature and increased astigmatism in offspring, suggesting that obesity-related factors may influence corneal shape through early developmental or biomechanical pathways (17). Although mechanistic explanations remain limited, these findings collectively supported the view that elevated BMI may contribute to corneal structural variation and astigmatic refractive development (17,18).

In contrast, evidence for hyperopia as a refractive outcome was less robust and inconsistent. Most studies did not demonstrate a stable association between BMI and hyperopia prevalence. However, emerging pediatric literature has emphasized hyperopic reserve as an intermediate risk marker for later myopia. In a cluster-sampling study assessing BMI and hyperopia reserve, mean reserves were reported as +1.26 ± 0.43 D (emaciated),

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+1.26 ± 0.75 D (normal), +1.18 ± 0.48 D (hypertrophic), and +1.17 ± 0.74 D (obese), and children with suspected insufficient hyperopic reserve were observed to have higher weight and BMI values ($p < 0.05$). The highest detection rate of insufficient reserve was reported in obese children ($p = 0.048$), particularly obese boys ($p = 0.001$), suggesting that weight status may be associated with reduced physiological hyperopia in early childhood and thereby increased risk of subsequent myopia onset, though replication is needed (18,20).

A qualitative synthesis of limitations across included studies indicated that the majority were cross-sectional and thus unable to determine temporal directionality between BMI and refractive development. Many studies adjusted for age and sex, and several incorporated parental myopia, near work, outdoor exposure, and socioeconomic indicators, but confounding remained a central concern. The potential for reverse causation was frequently raised, as myopic children may spend more time in sedentary indoor activities that predispose to weight gain, while overweight children may spend less time outdoors and more time on screens and near tasks, both of which are recognized correlates of myopia risk (22,23). Mendelian randomization approaches were also described in the evidence base and suggested that causal effects of obesity on myopia may not be consistent, reinforcing the possibility that observational associations reflect shared determinants rather than direct causality (23).

Table 1. Characteristics of Key Included Studies on BMI and Refractive Outcomes

Study	Country/Population	Design	Age Group	Exposure	Outcome(s)	Key Finding Direction
Rattan et al. (7)	Mixed/clinical population	Cross-sectional	Noted in study	BMI categories	Refractive error types	BMI categories associated; strongest in underweight ($p < 0.006$)
Chen et al. (11)	China	Cross-sectional	7–14 years	Height/BMI	Refractive error	Height growth correlated with myopia
Zheng et al. (12)	China schoolchildren	Cross-sectional	School-age	BMI	Myopia	Inverse L-shaped BMI–myopia; risk ↑ until BMI≈25 then plateau
Peled et al. (13)	Nationwide adolescents	Cross-sectional	Adolescents	BMI	Myopia/high myopia	J-shaped association; extremes linked to higher myopia risk
Shi et al. (14)	NHANES 1999–2008	Cross-sectional	Adolescents/young adults	WWI	Myopia	Higher WWI associated with reduced myopia odds
Yin et al. (15)	China nationwide	Cross-sectional	Children/adolescents	BMI	Myopia/high myopia	Both low/high BMI increased risk; stronger in males
Roy et al. (16)	India adults	Cross-sectional	Adults	BMI, height	Ocular biometrics/refraction	Higher BMI tended toward hyperopia; height related to longer AL
Han et al. (17)	Offspring cohort	Cross-sectional	Children	Maternal BMI	Astigmatism/corneal curvature	Maternal overweight/obesity linked to astigmatism
Lee et al. (19)	Korea (KNHANES)	Cross-sectional	Children/adolescents	BMI	High myopia	Obesity linked to high myopia; sex-specific effects
Ye et al. (21)	China schoolchildren	Cross-sectional	Early school years	Height/weight	Refraction & biometrics	Height strongest predictor; weight linked with myopic shifts
Kim et al. (22)	Korea children	Cross-sectional	Children	BMI & covariates	Myopia/high myopia	BMI not linked to general myopia, linked to high myopia
Bai et al. (23)	NHANES + MR	Cross-sectional + MR	Mixed ages	BMI	Myopia	Observational association; MR mixed/limited causal support

Table 2. Outcome-Wise Evidence Synthesis

Outcome	Evidence Pattern	Stronger in Which Group	Key Notes
Myopia	Most consistent association; often nonlinear (J-shaped / inverse L-shaped) (12,13,15,19)	Adolescents; males in some datasets (13,15,19)	Confounding by near work/outdoor time likely; reverse causation possible (22,23)
High myopia	BMI more consistently associated with severe myopia than mild/moderate (19,22)	Sex-specific patterns (19,22)	Suggests BMI may relate to progression/severity rather than onset
Astigmatism	Increasing BMI associated with higher risk/severity (17,18)	Adolescents; with-the-rule subtype	Maternal BMI influences corneal curvature; suggests biomechanical pathway (17)
Hyperopia	Inconsistent/insufficient evidence		Few studies directly assess hyperopia prevalence
Hyperopic reserve	Higher BMI linked with insufficient reserve; obese boys higher detection rate (18,20)	Preschool boys	Reserve is a predictor of future myopia; needs replication

The included evidence base was dominated by cross-sectional studies conducted in children and adolescents, with several large national datasets contributing substantial sample sizes and enabling identification of nonlinear BMI–myopia associations (Table 1). In Chinese schoolchildren, an inverse L-shaped pattern was described, in which myopia risk increased with BMI up to approximately 25 kg/m² and then plateaued, indicating threshold effects rather than simple linearity (12). A nationwide adolescent dataset further demonstrated a J-shaped association, suggesting that both low and high BMI categories could be linked to increased odds of myopia and high myopia, with stronger effects among males (13,15). Ocular biometry studies highlighted that height and body weight were systematically linked to axial length and chamber depth, while higher BMI showed a tendency toward more hyperopic refractions in some adult cohorts, emphasizing that BMI may capture metabolic or adiposity-related influences distinct from skeletal growth (16,21).

Outcome-wise synthesis (Table 2) indicated that myopia and high myopia were more consistently associated with BMI than hyperopia. In particular, the reviewed evidence suggested that BMI may show stronger relationships with severe refractive phenotypes, as several Korean datasets reported obesity-linked increases in high myopia rather than mild-to-moderate myopia, and sex-specific patterns were repeatedly noted (19,22). A metabolic composite index, TyG-BMI, showed a measurable increase in myopia odds in the highest category compared with the lowest (OR = 1.20; 95% CI: 1.0–1.5; $p < 0.05$), strengthening the argument that metabolic status may be relevant to refractive risk beyond anthropometric size alone (23). Astigmatism demonstrated relatively consistent positive associations with BMI and was further supported by maternal BMI findings linked to offspring corneal curvature and astigmatism, suggesting that obesity-related exposures may influence corneal geometry through developmental or biomechanical pathways (17). Evidence regarding hyperopia prevalence remained inconclusive; however, data on hyperopic reserve showed statistically significant differences in detection rates among obese children and obese boys in particular, indicating that elevated BMI may be associated with reduced physiological hyperopia in early childhood and thus a potential predisposition to later myopia onset (18,20).

DISCUSSION

The evidence synthesized in this narrative review suggests that BMI is associated with certain refractive outcomes, most consistently with myopia and high myopia, and also with astigmatism, while evidence for hyperopia remains limited and inconsistent. Across multiple datasets—particularly in children and adolescent associations between BMI and myopia often followed nonlinear patterns such as inverse L-shaped and J-shaped curves, implying that risk may not increase proportionately with BMI but may vary across underweight, normal weight, overweight, and obese categories (12,13,15,19). Importantly, these patterns indicate that extremes of weight status may represent biologically or behaviorally distinct risk states rather than reflecting a simple dose–response relationship. While several studies linked higher BMI to increased odds of myopia, other analyses using alternative anthropometric indices, such as weight-adjusted waist index, suggested inverse associations, highlighting that the apparent relationship may depend on whether the exposure captures adiposity distribution, metabolic risk, or general body proportionality (14). Consequently, BMI may act less as a direct causal driver and more as a marker of broader physiological and behavioral environments relevant to refractive development.

A recurring finding across ocular biometry research is the close relationship between general body growth—especially height—and ocular elongation. Taller children and adolescents tend to have longer axial lengths and deeper vitreous chambers, which are structural correlates of myopic refraction (16,21). These biometric trends support the concept that ocular development may be synchronized with somatic growth, particularly during early school years and puberty. However, BMI is distinct from height and skeletal growth because it reflects weight relative to stature and may integrate adiposity and metabolic status. Some cohorts reported that higher BMI was linked with more hyperopic refractions, which may reflect differences in ocular shape, lens parameters, or growth tempo not fully captured by axial length alone (16). This divergence suggests that BMI may influence refractive development through pathways distinct from those of height, potentially involving metabolism, inflammation, and lifestyle patterns.

The association between BMI and high myopia appears clinically meaningful because severe myopia confers greater lifetime risk of retinal and optic nerve complications. Several Korean analyses indicated that obesity was more strongly related to high myopia than to mild or moderate myopia, suggesting that weight status may play a role in progression or severity rather than simply in myopia onset (19,22). Sex-specific effects were also noted, with obese boys and overweight/obese girls demonstrating higher high-myopia risk in stratified analyses, implying that hormonal milieu, growth trajectories, or behavioral differences may modify the relationship (19,22). These findings may be relevant in clinical counseling because they link a modifiable health factor—weight status—to a severe vision-risk phenotype, although causality cannot be inferred from the largely cross-sectional evidence.

Astigmatism showed a comparatively consistent relationship with BMI, particularly with rising BMI associated with increased risk and severity of astigmatic refractive error. Evidence supporting this association included adolescent population findings as well as data linking maternal pre-pregnancy overweight and obesity to offspring corneal curvature and astigmatism, suggesting developmental and biomechanical influences on corneal geometry (17). Obesity-related alterations in extracellular matrix remodeling, inflammation, and biomechanical load have been proposed as potential explanations, though direct mechanistic ocular studies remain limited. Nevertheless, the reproducibility of the association across populations suggests that obesity may influence refractive outcomes beyond axial elongation alone, potentially through corneal structural pathways.

Hyperopia remains the least clear refractive outcome in relation to BMI. Most studies did not show a stable association between BMI and hyperopia prevalence, and the evidence base is comparatively sparse. However, newer pediatric work focusing on hyperopic reserve—an early-life refractive buffer that predicts later myopia onset—suggests that elevated BMI may be linked to insufficient reserve. The observation that obese children, especially obese boys, demonstrated the highest detection rate of insufficient reserve and statistically significant BMI differences between reserve categories provides a plausible early pathway linking weight status with myopia risk (18,20). Despite this promise, hyperopic reserve findings require replication in additional cohorts, ideally with cycloplegic refraction and longitudinal follow-up to determine whether BMI-related reserve differences translate into incident myopia.

A central interpretive challenge is confounding. BMI is strongly correlated with behaviors and exposures that independently influence myopia risk, including reduced outdoor time, reduced physical activity, increased near work, and prolonged screen exposure. Overweight children frequently spend more time indoors and engage in sedentary activities, both of which are associated with reduced exposure to bright outdoor light, a protective factor against myopia development. Socioeconomic status, educational intensity, and urban living may further confound observed relationships because these variables influence both BMI distributions and myopia prevalence. Several studies adjusting for outdoor time, near work, and socioeconomic indicators reported attenuation of associations, suggesting that behavioral mediation and residual confounding remain plausible explanations (22,23). The predominance of cross-sectional designs also leaves reverse causation unresolved, wherein myopic children may adopt behaviors that increase BMI rather than BMI increasing myopia risk. Mendelian randomization evidence remains mixed, and the absence of consistent genetic causal support further suggests that observational associations may reflect shared environmental determinants more than direct biological causality (23).

From a clinical and public health standpoint, the most actionable implication is not necessarily that BMI directly causes myopia, but that integrated lifestyle interventions may simultaneously benefit refractive health and metabolic health. Promoting outdoor physical activity, reducing excessive near work and screen exposure, and supporting healthy dietary patterns are plausible strategies that address both obesity and myopia risk pathways. If future longitudinal studies confirm that high BMI or metabolic dysregulation contributes to severe myopia progression, weight management could become an even more relevant component of pediatric eye-health promotion. Therefore, future research should prioritize prospective cohorts with repeated refractive and ocular biometric measures, objective assessments of outdoor light exposure, and more precise adiposity indices, such as body fat percentage or waist measures, to disentangle mediation from confounding and establish temporal directionality.

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CONCLUSION

This narrative review suggests that BMI is associated with certain refractive outcomes, with the most consistent evidence observed for myopia—particularly high myopia—and for astigmatism, while evidence linking BMI to hyperopia remains limited and inconclusive. The relationship between BMI and myopia frequently appears nonlinear, and associations may be modified by age, sex, and growth patterns, with severe refractive phenotypes showing stronger links to obesity in several populations. Emerging pediatric evidence also indicates that elevated BMI may be associated with insufficient hyperopic reserve, a potential early indicator of future myopia onset, although this requires longitudinal validation. Given the predominance of cross-sectional studies and the high likelihood of confounding and reverse causation, current findings should be interpreted as associations rather than proof of causality. Nevertheless, lifestyle interventions that increase outdoor activity and reduce sedentary screen-based behaviors remain a clinically and public health relevant strategy that may improve both refractive development and weight-related health outcomes, while future large-scale longitudinal studies with standardized refractive assessment and precise adiposity measures are needed to clarify biological pathways and causal directionality (12–15,17–23).

REFERENCES

1. Ball GD, Sharma AK, Moore SA, Metzger DL, Klein D, Morrison KM, et al. Measuring severe obesity in pediatrics using body mass index-derived metrics from the Centers for Disease Control and Prevention and World Health Organization: a secondary analysis of CANadian Pediatric Weight management Registry (CANPWR) data. Eur J Pediatr. 2023;182(8):3679–3690.
2. Bourne RRA, Stevens GA, White RA, Smith JL, Flaxman SR, Price H, et al. Causes of vision loss worldwide, 1990–2010: a systematic analysis. Lancet Glob Health. 2013;1(6):e339–e349.
3. Cheung N, Wong TY. Obesity and eye diseases. Surv Ophthalmol. 2007;52(2):180–195.
4. Wolffsohn JS, Bhogal G, Shah S. Effect of uncorrected astigmatism on vision. J Cataract Refract Surg. 2011;37(3):454–460.
5. Holden BA, Fricke TR, Wilson DA, Jong M, Naidoo KS, Sankaridurg P, et al. Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. Ophthalmology. 2016;123(5):1036–1042.
6. Koomanaee S, Tabrizi M, Naderi N, Rad AH, Moghaddam KB, Dalili S. Parental anthropometric indices and obesity in children. Acta Med Iran. 2016;54:270–275.
7. Rattan SA, Alrubaie A, Salih F, Abdalla SO, Hussein SD, Tariq FA. A correlation between body mass index and refractive errors. Acta Fac Med Naissensis. 2023;40(2):199–207.
8. Wong TY, Foster PJ, Johnson GJ, Klein BE, Seah SK. The relationship between ocular dimensions and refraction with adult stature: the Tanjong Pagar Survey. Invest Ophthalmol Vis Sci. 2001;42(6):1237–1242.
9. Heymsfield SB, Gallagher D, Mayer L, Beetsch J, Pietrobelli A. Scaling of human body composition to stature: new insights into body mass index. Am J Clin Nutr. 2007;86(1):82–91.
10. Joseph L, Wasir JS, Misra A, Vikram NK, Goel K, Pandey RM, et al. Appropriate values of adiposity and lean body mass indices to detect cardiovascular risk factors in Asian Indians. Diabetes Technol Ther. 2011;13(9):899–906.
11. Chen J, Chen Z, Lin S, Zhang J, Wang Q, Zhong H, Cai D. Correlation analysis for school-age children's height and refractive errors. Adv Clin Exp Med. 2018;27(8).
12. Zheng T, Fu W, Jiang S, Yang X. Inverse L-shaped association between body mass index and myopia in Chinese schoolchildren: a pilot study. J Multidiscip Healthc. 2024;17:1839–1846.
13. Peled A, Nitzan I, Megreli J, Derazne E, Tzur D, Pinhas-Hamiel O, et al. Myopia and BMI: a nationwide study of 1.3 million adolescents. Obesity (Silver Spring). 2022;30(8):1691–1698.
14. Shi XH, Dong L, Zhang RH, Wei WB. Association between weight-adjusted waist index and myopia in adolescents and young adults: results from NHANES 1999–2008. BMC Ophthalmol. 2024;24(1):14.
15. Yin C, Gan Q, Xu P, Yang T, Xu J, Cao W, et al. Weight status and myopia in children and adolescents: a nationwide cross-sectional study of China. Nutrients. 2025;17(2):260.
16. Roy A, Kar M, Mandal D, Ray RS, Kar C. Variation of axial ocular dimensions with age, sex, height, BMI—and their relation to refractive status. J Clin Diagn Res. 2015;9(1):AC01.
17. Han Y, Lv H, Cao Y, Wu J, Zeng X, Pazo EE, et al. Association between maternal pre-pregnancy body mass index and astigmatism and corneal curvature in offspring: a cross-sectional study. Clin Ophthalmol. 2025;19:3371–3380.
18. Lei J, Zhou X, He J, Liu L. Association between body mass index and suspected insufficient hyperopia reserve in preschool children. Chinese Journal of Child Health Care. 33(10):1151.
19. Lee S, Lee HJ, Lee KG, Kim J. Obesity and high myopia in children and adolescents: Korea National Health and Nutrition Examination Survey. PLoS One. 2022;17(3):e0265317.
20. Noh YH, Jung KI. The relationship between myopia and obesity in adults. Korean J Ophthalmol. 2024;38(2):137.
21. Ye S, Liu S, Li W, Wang Q, Xi W, Zhang X. Associations between anthropometric indicators and both refraction and ocular biometrics in a cross-sectional study of Chinese schoolchildren. BMJ Open. 2019;9(5):e027212.
22. Kim H, Seo JS, Yoo WS, Kim GN, Kim RB, Chae JE, et al. Factors associated with myopia in Korean children: Korea National Health and Nutrition Examination Survey 2016–2017 (KNHANES VII). BMC Ophthalmol. 2020;20(1):31.
23. Bai WY, Zhang HW, Ye XF, Xu JF, Guo XJ, He J. Association between body mass index and myopia: results from NHANES and Mendelian randomization. Ophthalmic Epidemiol. 2025:1–10.