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Oxidation balance scores are positively associated with the occurrence and severity of myopia in adults: results from the National Health and Nutrition Examination Survey 2007–2008

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Purpose: The purpose of this cross-sectional study was to investigate the relationship between oxidation balance scores (OBSs) and myopia.

Methods: Participant information came from the National Health and Nutrition Examination Survey (NHANES) 2007–2008. The relationship between OBSs and myopia was analyzed using a restricted cubic spline, generalized linear regression, trend analysis, and ordinal logistic regression. The important components of the OBS in myopia were analyzed using XGBoost, random forest, and AdaBoost.

Results: The data of 5,187 participants from NHANES were collected, and a preliminary analysis was conducted. We found that an association between OBSs and myopia was only found in participants aged ≥ 20 years (n = 4,253). There was a linear relationship between OBSs and the occurrence of myopia in them. The logistic regression showed that OBSs were correlated with an increased incidence of myopia after adjusting for all confounders (OR: 1.01, 95% CI [1.00, 1.02]). The trend test showed that the higher the OBS, the higher the likelihood of developing myopia (p for trend < 0.05). There was a nonlinear relationship between OBSs and myopia severity according to a generalized additive model (β = 0.01, 95% CI [0.00, 0.01], $p < .01$). The ordered logistic regression analysis showed that for every unit increase in OBS, the likelihood of myopia severity increased by 11% after adjusting for all confounders. We also found that calcium was an important OBS component related to the incidence of myopia.

Conclusions: OBS is positively associated with the occurrence and severity of myopia in adults ≥ 20 years of age, and calcium is an important OBS component related to the incidence of myopia.

Myopia is a common eye disease in which excessive eyeball elongation causes images of distant objects to be focused in front of the retina, leading to blurred distance vision, and it is becoming increasingly prevalent globally [1]. It has a prevalence of 10–30% in the adult populations of most countries [2]. Many studies have indicated that myopia causes a variety of ocular pathological changes and eye conditions, including cataracts, glaucoma, myopic macular degeneration, and retinal detachment [3]. The risk factors for myopia include inheritance, environment (e.g. time spent outdoors, light levels, Spectral composition of light), dietary habits, and lifestyle. In a review, Tedja et al. demonstrated that variants of genes, such as LRPAP1, NDUFAF7, P4HA2, SCO2, SLC39A5, UNC5D, and ZNF644, are associated with high myopia [4]. Randomized controlled trials have shown that spending more time outdoors during childhood reduces the incidence of myopia in adulthood by 20% [5,6]. Epidemiological and pathogenetic studies have shown a close correlation between high refined grain and high sugar dietary habits and the occurrence of myopia [7,8]. These studies have indicated that life and dietary interventions may improve the myopia condition.

Oxidative stress (OS) is a stress state that occurs when the normal metabolic activities of organs are disrupted by internal or external stimuli, resulting in an imbalance between oxidation and antioxidation. In recent years, OS has received considerable attention and is considered a key common pathway for the occurrence of various diseases [9]. Free radicals can increase susceptibility to various diseases by altering gene expression or damaging lipids, proteins, and DNA in critical developmental regions. Studies have shown that various factors can trigger the accumulation of reactive oxygen species (ROS) and reactive nitrogen species (RNS) in the retina and choroid, leading to lipid peroxidation, excessive production of malondialdehyde, induction of choroidal cell apoptosis, disruption of normal ocular growth regulation mechanisms, excessive ocular growth, and the development of myopia [10].

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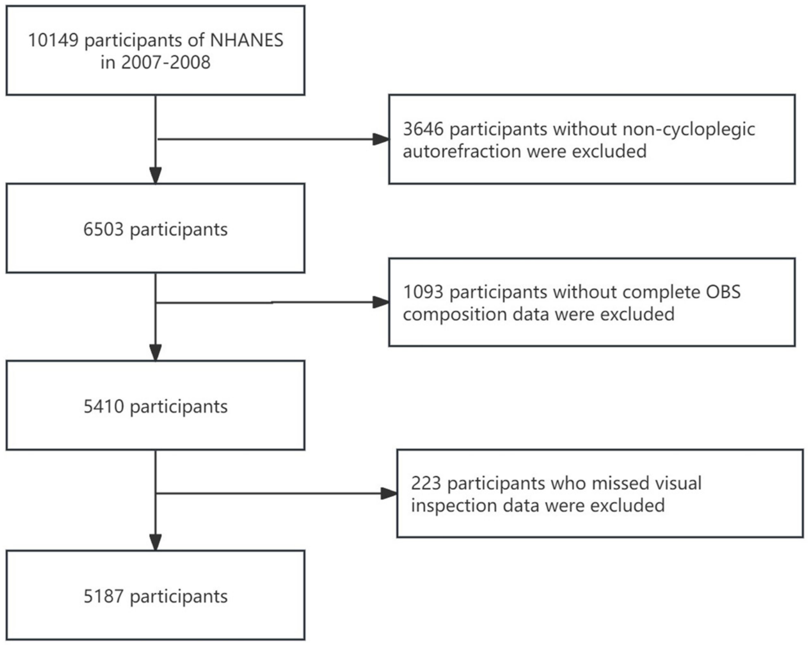

Figure 1. Flowchart of participant selection.

The oxidation balance score (OBS) represents the oxidative balance of a person's dietary pattern and lifestyle using the merged intake of anti- and prooxidants. OBS assessment evaluates OS generated by diet and lifestyle, with a higher OBS indicating more antioxidants than prooxidants [11]. Many studies have shown that OBSs are correlated with the occurrence and development of various diseases: in patients with chronic obstructive pulmonary disease, a higher OBS is associated with a lower risk of frailty [12]; OBSs are negatively correlated with the risk of colorectal cancer in elderly women [13]; and high OBSs are associated with a reduced risk of postmenopausal osteoporosis in Iranian women [14]. However, the relationship between OBSs and myopia has not been studied. Therefore, in this study, we explored the relationship between OBSs and myopia based on National Health and Nutrition Examination Survey (NHANES) data using various statistical analysis methods.

METHODS

Data source and study participants: The data were collected from NHANES, a program of studies designed to assess the health and nutritional status of adults and children in the United States (CDC). The survey is unique in that it combines interviews and physical examinations. NHANES is a major National Center for Health Statistics (NCHS) program. NCHS is part of the Centers for Disease Control and Prevention (CDC) and is responsible for producing vital health statistics for the United States. The data from NHANES will be used to assess the nutritional status, lifestyle, and disease status of the population as well as the relationships between them. A total of 10,149 participants participated in NHANES 2007-2008. We excluded data from 3,646 participants without noncycloplegic autorefraction, 1,093 participants without complete OBS composition data, and 223 participants who lacked visual inspection data. Data of 5,187 participants were used in the preliminary analysis. The flowchart for participant selection is shown in Figure 1.

Examination and variable definitions: The refractive error, sphere, cylinder, and axis of the eyes were measured using a Nidek Auto Refractor Model ARK-760 (Nidek Co Ltd, Gamagori, Japan) in NHANES. The spherical equivalent (SE) refractive error was determined by summing the spherical value with half the cylinder value.

Given the strong correlation observed between the SE values of the right and left eyes, the decision was made to exclusively utilize data from the right eye for analysis in this particular study [15]. Myopia was defined as having an SE of −0.50 diopters or less, with mild myopia falling between −3.00 and −0.50 diopters, moderate myopia between −6.00 and −3.00 diopters, and high myopia at −6.00 diopters or less [15].

The OBS was calculated based on dietary and lifestyle components via the methods of the study of Zhang et al. [16]. The dietary components included dietary fiber, carotene, riboflavin, niacin, calcium, magnesium, zinc, total folate, vitamin B6, vitamin B12, vitamin C, vitamin E, copper, selenium, total fat, and iron. Lifestyle components included physical activity, alcohol consumption, body mass index (BMI), and cotinine. We also collected other features of the included population, including age, poverty income ratio (PIR), vitamin A (VA), vitamin D (VD), 25-hydroxyvitamin D2 (serum 25(OH)D2), 25-hydroxyvitamin D3 (serum 25(OH)D3), sleep duration, sex, marital status, and education level, as well as hypertension, diabetes, asthma, sleep trouble, sleep disorder, and depression score grades. However, smoking indicators, drinking indicators, physical activity (PA) scores, BMI, and TV-watching duration were not listed independently because they were OBS components. The above variables were only in the 2007–2008 NHANES, so we only analyzed the data for this year. It is worth noting that PA scores were calculated according to the PA questionnaire in NHANES developed by Ainsworth et al. [17].

Statistical analysis: The continuous variables were described by the median (25%, 75%), and their differences were compared using the Mann–Whitney U test between the two groups and the Kruskal–Wallis test among multiple groups. Count data were compared using a chi-squared test and expressed by n (%). A restricted cubic spline (RCS) analysis revealed a linear relationship between OBSs and myopia occurrence. Logistic regression analysis and trend analysis were used to explore their associations further. We also found a nonlinear relationship between OBSs and myopia severity via a generalized additive model. We further verified this relationship via generalized linear regression and ordered logistic regression analysis. Next, the values of OBS components in the non-myopia and myopia groups, as well as among the different myopia severity groups, were compared. XGBoost, AdaBoost, and random forest were used to evaluate the importance of OBS components in myopia occurrence and severity separately. Finally, all the data were analyzed using SPSS and R software. Statistical significance was set at $p < .05$.

RESULTS

Determination of study participants: We first explored the relationship between myopia and OBSs via an RCS. The results show a linear relationship between them (p for nonlinear > 0.05). Because age is associated with myopia, we countered the age subgroup analysis to further explore the relationship between OBSs and myopia in both adolescent and adult populations. The results show that OBSs promote the occurrence of myopia (OR: 1.02, 95% CI [1.01, 1.03]) in participants aged ≥ 20 years old. In addition, the results persisted after adjusting for sex. However, in participants aged < 20 years old, there was no relationship between OBSs and myopia, with or without adjusting for sex (Table 1). Hence, the participants aged ≥ 20 years old were selected for further analysis.

A total of 4,253 participants aged ≥ 20 years old were selected for the next analysis, including 1,614 participant with myopia (mild myopia: 1,421, moderate myopia: 368, high myopia: 123). The participants were separated into two groups, the myopia group and the non-myopia group, and the differences in baseline characteristics between the two groups were analyzed (Table 2). We found that there were differences between the two groups in terms of age ($p < .01$), PIR ($p < .01$), OBS ($p < .01$), marital status ($p < .01$), education level ($p < .01$), hypertension ($p = .01$), and asthma ($p = .01$). These significant variables were considered in further analyses.

Correlation analysis between OBSs and myopia: The relationship between OBSs and myopia occurrence was explored via RCS. The results show a linear relationship between them

Table 1. Age-stratified logistic regression between OBSs and myopia.

Variable	N	No-myopia	Myopia	OR	95%CI	P value
Without adjustment						
Total	5187	3168	2019	1.02	[1.01,1.03]	<0.01
<20, years	934	529	405	1.01	[1.00,1.03]	0.27
≥20, years	4253	2639	1614	1.02	[1.01,1.03]	<0.01
Adjust for sex						
Total	5187	3168	2019	1.02	[1.01,1.03]	<0.01
<20, years	934	529	405	1.01	[0.99,1.03]	0.25
≥20, years	4253	2639	1614	1.02	[1.01,1.03]	<0.01

Abbreviation: OBS: oxidative balance score, CI: confidence interval, OR: odd ratio

Table 2. Baseline features of the adult.

Variable	No-myopia (n=2639)	Myopia (n=1614)	Z/χ 2	P-value
Age, year	53.000[38.000,66.000]	46.000[32.000,61.000]	8.393	<0.001
PIR	2.120[1.140,3.980]	2.420[1.260,4.380]	-3.664	<0.001
VA, mg	475.000[256.000,743.000]	478.000[267.000,786.000]	-1.36	0.174
VD, mg	0.000[0.000,0.100]	0.000[0.000,0.000]	0.129	0.866
serum 25(OH)D2, nmol/l	1.450[1.450,1.450]	1.450[1.450,1.450]	0.189	0.8
Sleep duration, h	7.000[6.000,8.000]	7.000[6.000,8.000]	0.535	0.582
serum 25(OH)D3, nmol/l	56.700[40.400,73.200]	56.800[40.500,73.800]	-0.236	0.814
OBS	19.000[14.000,25.000]	21.000[15.000,26.000]	-4.439	<0.001
Sex, n (%)				
Male	1303(49.375)	733(45.415)	6.292	0.012
Female	1336(50.625)	881(54.585)		
Obesity, n (%)				
No	1630(62.095)	996(62.095)	0	1
Yes	995(37.905)	608(37.905)		
Married statue, n (%)				
Never marital	355(13.452)	335(20.782)	40.165	<0.001
Marital/living with partner	613(23.228)	327(20.285)		
Widowed/divorced/separated	1671(63.319)	950(58.933)		
Education level, n (%)				
Less than high school	833(31.565)	360(22.319)	60.128	<0.001
High school or equivalent	685(25.957)	384(23.807)		
High school above	1121(42.478)	869(53.875)		
Hypertension, n (%)				
Yes	969(36.746)	525(32.548)	7.738	0.005
No	1668(63.254)	1088(67.452)		
Diabetes, n (%)				
Yes	338(13.065)	178(11.139)	3.391	0.066
No	2249(86.935)	1420(88.861)		
Asthma, n (%)				
Yes	320(12.135)	239(14.817)	6.303	0.012
No	2317(87.865)	1374(85.183)		
Sleep trouble, n (%)				
No	2012(76.270)	1219(75.527)	0.303	0.582

Variable	No-myopia (n=2639)	Myopia (n=1614)	Z/χ 2	P-value
Yes	626(23.730)	395(24.473)		
Sleep disorder, n (%)				
No	2410(91.565)	1482(91.993)	0.24	0.624
Yes	222(8.435)	129(8.007)		
Depression score grade, n (%)				
[2-5]	1904(74.784)	1167(75.145)	2.251	0.69
[6-10]	387(15.200)	240(15.454)		
[11-15]	156(6.127)	93(5.988)		
[16-20]	75(2.946)	35(2.254)		
[21-28]	24(0.943)	18(1.159)		

Abbreviation: OBS: oxidative balance score, PIR: poverty income ratio, VA: vitamin A, VD: vitamin D, serum 25(OH)D2: 25-hydroxyvitamin D2, serum 25(OH)D3: serum 25-hydroxyvitamin D3 (p for overall < 0.01; p for nonlinear = 0.013, the RCS diagram does not show). Therefore, we performed logistic regression analysis and trend test analysis to further explore the details of their relationship. The results of logistic regression show that OBS is a risk factor for the occurrence of myopia (Model 1 OR: 1.02, 95% CI [1.01, 1.03]). The results persisted after adjusting for age, PIR, marital status, educational level (Model 2 OR: 1.01, 95% CI [1.00, 1.02]), and all confounders, including the above variables in addition to hypertension, diabetes, and asthma (Model 3 OR: 1.01, 95% CI [1.00, 1.02]; Table 3). The trend test results show that the higher the OBS, the higher the likelihood of developing myopia, even after adjusting for all the above confounders (all p for tend < 0.05, Table 3). Notably, although diabetes rates did not differ significantly between the myopia and non-myopia groups, most research has shown a relationship between diabetes and myopia [18,19]. Therefore, we included diabetes as a covariate in Model 3.

Correlation analysis between OBSs and myopia severity: We explored the relationship between OBSs and myopia severity via a generalized additive model. The result of the generalized additive model showed a nonlinear relationship between OBSs and myopia severity (β = 0.01, 95% CI [0.00, 0.01], p < 0 .01). We then continued to explore the relationship between them in detail via generalized linear regression and ordered logistic regression analysis. The results of the generalized linear regression analysis are shown in Table 4. In Model 1, the β between the OBSs and SE was 0.01 (β = 0.01, 95% CI [0.01, 0.012]). In Model 2, the β between the OBSs and SE was 0.005 (β = 0.01, 95% CI [0.00, 0.01]) after adjusting for age, PIR, marital status, and educational level. In Model 3, the β between the OBSs and SE was 0.005 (β = 0.01, 95% CI [0.0, 0.01]) after adjusting for age, PIR, marital status, educational level, hypertension, diabetes, and asthma. The results of the ordered logistic regression analysis show that for every unit increase in OBS, the likelihood of myopia increased by 2% (OR: 1.02, 95% CI [1.01, 1.02], $p < .001$) in Model 1 (without adjustment), 1% (OR: 1.01, 95% CI [1.01, 1.02], $p < .05$) in Model 2 (adjusting for age, PIR, marital status, and educational level), and 1% (OR: 1.01, 95% CI [1.00, 1.02], $p < .01$) in Model 3 (adjusting for age, PIR, marital status, educational level, hypertension, diabetes, and asthma; Table 5).

Important OBS components related to myopia and its degree: All the above analysis results indicate that OBSs are

Table 3. Association analysis between OBS and myopia by setting OBS as continuous and categorical variable.

Models	Variable	OR [95%CI]	P-value	P for trend
Model 1				
As continuous variable		1.019[1.011,1.028]	<0.001	/
As categorical variable	Q1	reference		<0.001
	Q2	1.024[0.860,1.219]	0.419	
	Q3	1.262[1.057,1.507]	<0.001	
	Q4	1.402[1.180,1.665]	<0.001	
Model 2				
As continuous variable		1.010[1.000,1.019]	0.047	/
As categorical variable	Q1	reference		0.03
	Q2	0.966[0.802,1.163]	0.711	
	Q3	1.117[0.923,1.351]	0.254	
	Q4	1.190[0.985,1.437]	0.071	
Model 3				
As continuous variable		1.011[1.001,1.020]	0.03	/
As categorical variable	Q1	reference		0.018
	Q2	0.978[0.812,1.178]	0.814	
	Q3	1.133[0.936,1.371]	0.201	
	Q4	1.214[1.004,1.468]	0.045	

Model 1: no adjustment; Model 2: adjusted for age, PIR, married status, educational level; Model 3: adjusted for age, PIR, married status, educational level, Hypertension, diabetes, asthma. Abbreviation: OBS: oxidative balance score, CI: confidence interval

Table 4. Association between OBS and severity of myopia by a generalized additive linear model.

Model	β [95%CI]	P-value
Model1		
OBS	0.009[0.006,0.012]	<0.001
Molde2		
OBS	0.005[0.002,0.008]	0.003
Model3		
OBS	0.005[0.002,0.009]	0.002

Model 1: no adjustment; Model 2: adjusted for age, PIR, married status, educational level; Model 3: adjusted for age, PIR, married status, educational level, Hypertension, diabetes, asthma. Abbreviation: OBS: oxidative balance score, CI: confidence interval.

significantly related to myopia. Hence, we further explored the key components of OBSs. The results show that levels of total fat, riboflavin, niacin, vitamin B6, total folate, vitamin B12, vitamin E, calcium, magnesium, iron, zinc, copper, selenium, and cotinine differed between the myopia and non-myopia groups (Table 6). Dietary fiber, total fat, riboflavin, niacin, vitamin B6, total folate, vitamin B12, vitamin E ATE, calcium, magnesium, iron, zinc, copper, and selenium were significantly related to myopia severity (Table 7). Next, three kinds of importance rank analyses—XGBoost, random forest, and AdaBoost—were performed to screen the key OBS components. The three kinds of rank analysis results indicate that calcium and copper were key components of OBSs related to the occurrence of myopia (Figure 2A-C). Moreover, calcium was a key component of OBSs related to myopia severity (Figure 2D-E). Therefore, we believe that calcium is an important OBS component related to myopia and its severity.

DISCUSSION

In this cross-sectional analysis of 5,187 participants, we found that 1,614 participants aged ≥ 20 years old had myopia. OBSs were significantly associated with myopia in participants aged ≥ 20 years old; however, OBSs were not correlated with myopia in participants aged < 20 years old. Therefore, participants aged ≥ 20 years old were enrolled and further explored. Further analysis indicated that there was a positive relationship between the OBS and the occurrence and severity of myopia. In addition, we found that Ca+ is an important component of OBS in myopia.

Many studies have shown that OBSs are associated with the occurrence and development of human diseases. A higher OBS indicates greater exposure to antioxidants than oxidants, reducing the risk of diseases such as chronic obstructive pulmonary disease (COPD) [12], depression [20] and insomnia [21], which is beneficial for maintaining the normal state of the patient's body. In this study, we first

Table 5. An ordered logistic regression analysis between OBS and myopia grade.

Model	Estimate	SE	T	OR	P-value
Model1					
OBS	0.023	0.004	5.224	1.023[1.014,1.023]	<0.001
0|1	0.941	0.092	10.189	2.562[2.138,3.071]	<0.001
1|2	2.719	0.103	26.404	13.164[12.392,18.555]	<0.001
2|3	4.197	0.135	30.993	66.487[50.988,86.698]	<0.001
Model2					
OBS	0.012	0.005	2.567	1.009[1.002,1.015]	0.01
0|1	0.366	0.154	2.386	1.442[1.068,1.949]	0.017
1|2	2.17	0.159	13.651	8.761[6.415,11.964]	<0.001
2|3	3.68	0.183	20.128	39.628[27.694,56.704]	<0.001
Model3					
OBS	0.013	0.005	2.751	1.013[1.004,1.023]	0.006
0|1	0.143	0.187	0.761	1.153[0.799,1.665]	0.447
1|2	1.949	0.191	10.189	7.020[4.826,10.213]	<0.001
2|3	3.459	0.211	16.37	31.789[21.010,48.000]	<0.001

Model 1: no adjustment; Model 2: adjusted for age, PIR, married status, educational level; Model 3: adjusted for age, PIR, married status, educational level, Hypertension, diabetes, asthma. Abbreviation: OBS: oxidative balance score, SE: standard deviation, CI: confidence interval, OR: Odds Ratio; 0:no-myopia; 1: mild-myopia; 2: moderate-myopia; 3: high-myopia.

Table 6. The difference of OBS components between myopia and no-myopia groups.

Variable	No-myopia (n=2639)	Myopia (n=1914)	F	P-value
Dietary fiber, g	14.300[9.900,20.000]	14.550[10.200,20.500]	-1.554	0.12
Total fat, g	67.560[47.070,93.960]	70.155[50.860,95.410]	-2.949	0.003
Carotene, RE	94.479[36.667,244.479]	94.083[39.833,241.479]	-0.311	0.756
Riboflavin, mg	1.871[1.360,2.522]	1.964[1.404,2.584]	-2.488	0.013
Niacin, mg	21.285[15.476,28.958]	22.281[16.577,30.858]	-3.594	<0.001
Vitamin B6, mg	1.693[1.233,2.345]	1.754[1.264,2.475]	-2.215	0.027
Total folate, mcg	342.000[249.500,472.000]	351.500[257.500,496.500]	-2.212	0.027
Vitamin B12, mcg	4.120[2.580,6.235]	4.325[2.770,6.335]	-2.497	0.013
Vitamin C, mg	66.550[31.450,117.800]	66.200[32.000,117.650]	-0.256	0.798
Vitamin E, mg	5.905[4.020,8.570]	6.170[4.235,8.710]	-2.205	0.027
Calcium, mg	765.000[538.000,1055.000]	837.500[572.500,1133.000]	-3.873	<0.001
Magnesium, mg	256.000[191.000,332.000]	263.500[199.500,346.500]	-2.182	0.029
Iron, mg	13.025[9.715,18.035]	13.510[10.015,19.050]	-2.599	0.009
Zinc, mg	9.865[7.165,13.750]	10.455[7.535,14.340]	-2.939	0.003
Copper, mg	1.113[0.839,1.482]	1.176[0.886,1.566]	-3.964	<0.001
Selenium, mcg	96.450[69.350,129.400]	100.000[73.450,130.750]	-2.494	0.013
Alcohol, g	0.000[0.000,4.250]	0.000[0.000,5.050]	-0.29	0.722
BMI, kg/m^2	28.150[24.610,32.090]	27.970[24.310,32.430]	0.667	0.505
PA total, MET	2400.000[840.000,7200.000]	2400.000[760.000,5940.000]	1.306	0.192
Cotinine, ng/ml	0.065[0.020,28.100]	0.055[0.018,4.670]	2.142	0.032

discovered that OBS is a risk factor for myopia and that it is positively correlated with SE. We believe this is related to the high sensitivity of the eyes to ROS. The retina has many blood vessels and a large blood flow, providing strong oxygen pressure to the retina, making it very sensitive to hypoxic conditions caused by an imbalance between free radical production and antioxidant defense [22]. A higher OBS indicates an imbalance in redox, with more antioxidants than oxidants, reduced lipid oxidation, and lower ROS production, leading to mitochondrial excitatory effects [23] and increased activity of the cellular antioxidant defense system, resulting in upregulation of IGF (which plays an important role in controlling eye growth relaxation) [24], which in turn leads to increased diopter and axial lengthening, resulting in myopia [25].

We analyzed the correlation between the components of OBS and myopia occurrence and severity. Significantly correlated components were sorted by importance, and it was found that calcium ions were the most important factor involved in myopia. Studies have shown that under conditions of imbalance between cellular prooxidants and antioxidants, the production of ROS is not only related to mitochondrial stimulation [26] and xanthine activation [27] but also to calcium-dependent nicotinamide adenine dinucleotide phosphate (NADPH) oxidase [28]. NADPH oxidase promotes the release of ROS from endothelial cells. The release of ROS stimulates nuclear factor-κB (NF-κB), leading to the release of more nitric oxide (NO). NO acts as a regulator of eye development in developing myopia [9]. Additionally, animal studies have shown that cyclic adenosine monophosphate (cAMP) can influence inositol 1,4,5-triphosphate (IP3) through protein kinase A (PKA), leading to phosphorylation of IP3 receptors on the endoplasmic reticulum (ER) membrane. This process opens calcium channels, resulting in the release of calcium ions from storage in the ER into the cytoplasm, thereby stimulating fibroblast activity [29]. This mechanism may impact the occurrence and progression of myopia.

This study was the first to reveal the relationship between OBS and myopia, but it has some limitations. First, the study did not determine a causal relationship between OBSs and myopia because it was a cross-sectional study which does not confirm the factor that occurred first. Second, the OBSs did not accurately represent participants' state of oxidation in the body because the weight of each component was the same when calculated OBS.

Conclusion: In summary, OBSs are positively associated with the occurrence and severity of myopia, and calcium is

Table 7. The difference of OBS components among different myopia degree groups.

Variable	No-myopia 0 (n=3454)	Mild-myopia (n=1421)	Moderate-myopia (n=368)	High-myopia (n=123)	F	P-value
Dietary fiber, g	14.300[9.900,20.000]	14.350[9.950,20.350]	15.200[10.850,21.450]	15.900[12.200,20.800]	9.488	0.023
Total fat, g	67.560[47.070,93.960]	68.815[50.135,93.430]	75.840[53.390,104.555]	71.250[50.285,95.485]	18.552	<0.001
Carotene, RE	94.479[36.667,244.479]	89.333[38.938,226.208]	115.896[46.458,275.313]	95.333[38.292,263.208]	7.303	0.063
Riboflavin, mg	1.871[1.360,2.522]	1.952[1.377,2.549]	2.006[1.454,2.676]	2.044[1.509,2.785]	10.569	0.014
Niacin, mg	21.285[15.476,28.958]	21.914[16.287,30.230]	22.972[16.805,32.433]	24.748[17.918,33.552]	19.108	<0.001
Vitamin B6, mg	1.693[1.233,2.345]	1.730[1.244,2.427]	1.810[1.292,2.649]	1.858[1.416,2.657]	9.955	0.019
Total folate, mcg	342.000[249.500,472.000]	344.500[252.500,487.500]	359.500[263.000,522.000]	401.500[292.000,537.500]	13.274	0.004
Vitamin B12, mcg	4.120[2.580,6.235]	4.255[2.740,6.265]	4.585[2.870,6.575]	4.940[2.855,6.875]	9.098	0.028
Vitamin C, mg	66.550[31.450,117.800]	65.850[32.000,118.000]	74.100[34.150,123.150]	56.650[26.550,103.500]	3.687	0.297
Vitamin E, mg	5.905[4.020,8.570]	5.970[4.075,8.510]	6.655[4.755,9.810]	6.455[5.025,9.290]	18.546	<0.001
Calcium, mg	765.000[538.000,1055.000]	826.000[563.500,1120.500]	892.500[603.000,1152.000]	864.500[610.500,1197.500]	20.589	<0.001
Magnesium, mg	256.000[191.000,332.000]	259.500[193.000,341.000]	271.000[211.000,355.000]	289.500[221.000,367.500]	15.365	0.002
Iron, mg	13.025[9.715,18.035]	13.315[9.905,18.525]	13.730[10.140,20.920]	14.645[10.725,21.155]	11.792	0.008
Zinc, mg	9.865[7.165,13.750]	10.320[7.325,14.040]	10.855[8.030,15.420]	10.965[8.505,15.230]	17.631	<0.001
Copper, mg	1.113[0.839,1.482]	1.158[0.871,1.549]	1.249[0.918,1.609]	1.239[1.030,1.697]	25.204	<0.001
Selenium, mcg	96.450[69.350,129.400]	99.000[72.450,130.000]	102.750[73.300,132.650]	103.250[84.450,136.350]	9.187	0.027
Alcohol, g	0.000[0.000,4.250]	0.000[0.000,5.200]	0.000[0.000,2.350]	0.000[0.000,4.700]	1.251	0.741
BMI, kg/m^2	28.150[24.610,32.090]	28.070[24.370,32.480]	27.930[24.270,32.700]	27.170[23.480,30.790]	2.33	0.507
PA total, MET	2400.000[840.000,7200.000]	2620.000[840.000,6000.000]	2040.000[660.000,5280.000]	1440.000[720.000,4800.000]	7.495	0.058
Cotinine, ng/ml	0.065[0.020,28.100]	0.063[0.019,8.130]	0.042[0.017,1.100]	0.031[0.011,0.529]	15.088	0.002

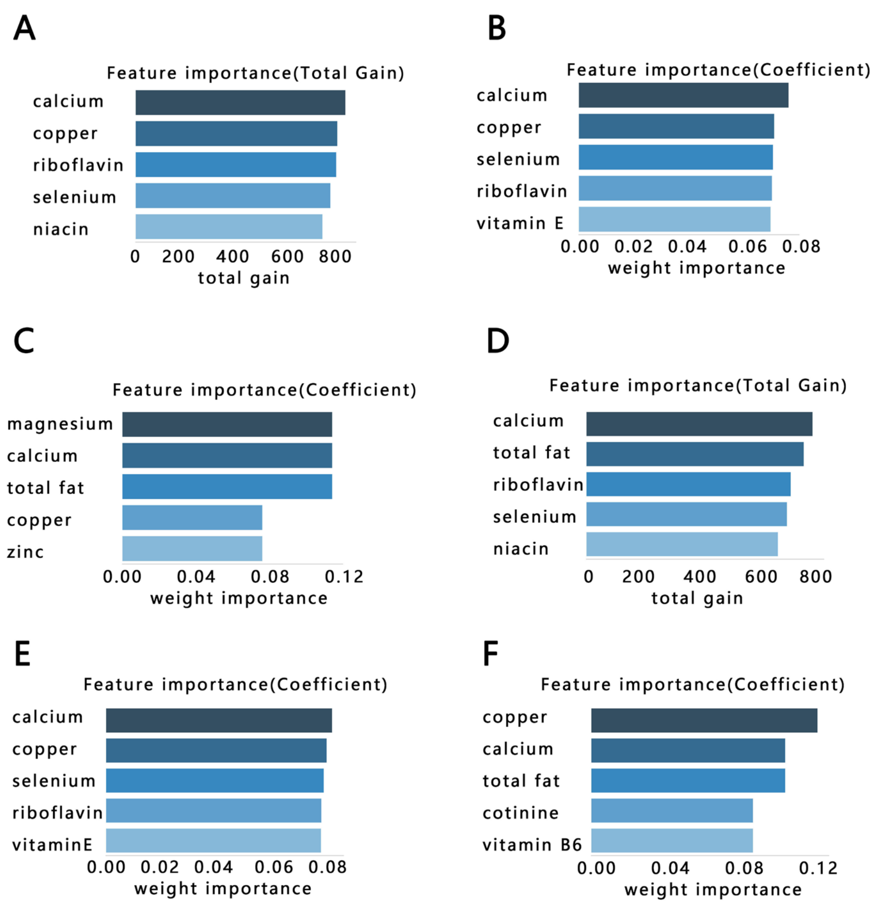

Figure 2. Screening of important OBS components related to myopia and its severity. The importance ranking bar chart of the top five factors in the occurrence of myopia using (**A**) XGBoost, (**B**) random forest, and (**C**) AdaBoost. The importance ranking bar chart of the top five factors in the severity of myopia using (**D**) XGBoost (**E**), random forest, and (**F**) AdaBoost.

an important OBS component related to the occurrence of myopia. This study highlights the importance of oxidative balance in the occurrence and severity of myopia in adults from the factors of diet and living habits.

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