Increased Prevalence of Myopia in the United States Between 1971-1972 and 1999-2004

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Objective: To compare US population prevalence estimates for myopia in 1971-1972 and 1999-2004.

Methods: The 1971-1972 National Health and Nutrition Examination Survey provided the earliest nationally representative estimates for US myopia prevalence; myopia was diagnosed by an algorithm using either lensometry, pinhole visual acuity, and presenting visual acuity (for presenting visual acuity ≥20/40) or retinoscopy (for presenting visual acuity ≤20/50). Using a similar method for diagnosing myopia, we examined data from the 1999-2004 National Health and Nutrition Examination Survey to determine whether myopia prevalence had changed during the 30 years between the 2 surveys.

Results: Using the 1971-1972 method, the estimated prevalence of myopia in persons aged 12 to 54 years was significantly higher in 1999-2004 than in 1971-1972 (41.6% vs 25.0%, respectively; $P<.001$). Prevalence estimates were higher in 1999-2004 than in 1971-1972 for black individuals (33.5% vs 13.0%, respectively; $P<.001$) and white individuals (43.0% vs 26.3%, respectively; $P<.001$) and for all levels of myopia severity (>–2.0 diopters [D]: 17.5% vs 13.4%, respectively [$P<.001$]; ≤–2.0 to >–7.9 D: 22.4% vs 11.4%, respectively [$P<.001$]; ≤–7.9 D: 1.6% vs 0.2%, respectively [$P<.001$]).

Conclusions: When using similar methods for each period, the prevalence of myopia in the United States appears to be substantially higher in 1999-2004 than 30 years earlier. Identifying modifiable risk factors for myopia could lead to the development of cost-effective interventional strategies.

Arch Ophthalmol. 2009;127(12):1632-1639

MYOPIA, OR NEARSIGHTedness, is a common condition[1] in which the image of an object seen in the distance is focused anterior to the retina and is consequently out of focus when it reaches the retina. Blurred vision caused by myopia can be treated by corrective lenses (eyeglasses or contact lenses) or refractive surgery.

The cause of refractive error is not known, but it is likely due to both environmental and genetic factors.[2,3] In the earliest report from a nationally representative sample of the US population, the prevalence of myopia was estimated to be 25% in persons aged 12 to 54 years.[4] Recently, several studies have documented an increased prevalence of myopia in younger birth cohorts,[5,6] suggesting that environmental risk factors for myopia may have become more prevalent. In particular, studies in Asian populations have reported epidemics of myopia in younger generations, possibly attributed to the near-work demands imposed by more intensive education.[3,6]

Few data are available to address the question of whether myopia prevalence is increasing in the United States. We used data from the ongoing National Health and Nutrition Examination Survey (NHANES) to explore whether the prevalence of myopia was similar for persons aged 12 to 54 years in 1971-1972 and persons of the same ages examined in 1999-2004. Our previously reported estimates[7] of the prevalence of myopia in the United States in 1999-2004 were based on objective refraction measurements obtained from all 1999-2004 NHANES participants aged 12 years and older. However, in the 1971-1972 NHANES,[4] objective refraction measurements were obtained only if presenting visual acuity (VA) was 20/50 or worse. Consequently, the myopia prevalence reported for 1971-1972 was based on lensometry and algorithms using pinhole VA and presenting VA (for presenting VA ≥20/40) or retinoscopy (for presenting VA ≤20/50). The goal of the current study was to derive alternative estimates of myopia prevalence from the 1999-2004 NHANES data by applying the same methods used in 1971-1972. These alternative estimates were computed solely to allow valid comparisons with the 1971-1972 report and are not intended as a substitute for our previously reported values.[7]

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METHODS

The NHANES is an ongoing, nationally representative survey of the US civilian, noninstitutionalized population conducted by the National Center for Health Statistics, Centers for Disease Control and Prevention.[8,9] Participants are interviewed in their homes and subsequently undergo a comprehensive examination in a mobile examination center.[8]

OCULAR EXAMINATION

1971-1972

In 1971-1972,[10,11] eye examinations for participants aged 4 years and older were performed. These included monocular distance VA measurement while wearing current distance correction (if any), a pinhole test to approximate corrected VA if presenting VA was worse than 20/20, and detailed retinoscopy only for eyes with presenting VA of 20/50 or worse.[12]

1999-2004

In 1999-2004, vision examinations were conducted for participants aged 12 years and older using an autorefractor (Nidek ARK-760; Nidek Co, Ltd, Tokyo, Japan). The chart in the autorefractor was used to measure presenting VA separately for each eye with the participant wearing his or her usual distance vision correction. Corrective lenses were then removed and the autorefractor obtained 3 separate measurements of sphere, cylinder, and axis, which were automatically averaged to arrive at the final refraction measurements. For eyes with presenting VA of 20/30 or worse, the chart in the autorefractor was used to remeasure VA, this time with the aid of a correction determined by the final automated refraction measurements for that eye.

INFORMED CONSENT

1971-1972

Consent was obtained in a manner consistent with human subjects review standards in 1971-1972.[13] Study representatives visiting the households of potential participants described study procedures and answered questions about the study's purpose and potential risks and benefits of participation.[12] Written consent by parents or guardians was obtained for participants who were minors.

1999-2004

The 1999-2004 NHANES was reviewed and approved by the National Center for Health Statistics Research Ethics Review Board. All participants (or parents or guardians of minors) gave written informed consent after receiving a description of the study and potential risks of participation.

RACE/ETHNICITY

1971-1972

In 1971-1972, race was determined by the interviewer's observation or, if the interviewer could not ascertain race, by asking the participant. Hispanic status was not assessed.

1999-2004

All participants were asked to report their ethnicity and race in 1999-2004.[14] For comparison with 1971-1972 data, we used data from only non-Hispanic black and non-Hispanic white participants (hereafter denoted black and white, respectively) in the 1999-2004 NHANES.

DEFINITION OF MYOPIA

1971-1972

The following algorithm was used to classify right eyes as myopic or nonmyopic in the NHANES data collected in 1971-1972 (**Figure 1**). Presenting VA was measured using the participant's current distance vision correction if available.

If presenting VA was 20/20 or better, corrective lens status (for distance) was used to classify the eye as myopic or nonmyopic. If corrective lenses were worn, lensometry was performed and the eye was classified as myopic if the spherical equivalent measurement was less than 0 diopters (D) or as nonmyopic if the spherical equivalent measurement was 0 D or higher. If no corrective lenses were worn, the eye was considered to be nonmyopic.

If presenting VA was 20/25 to 20/40, both corrective lens status and estimated best VA (from pinhole testing) were used to classify the eye as myopic or nonmyopic and to determine the severity of the myopia. If corrective lenses were worn, lensometry was performed and the eye was classified as myopic if the spherical equivalent measurement was less than 0 D or as nonmyopic if the spherical equivalent measurement was 0 D or higher. The VA was remeasured using a pinhole to approximate best-corrected VA. If the lensometry spherical equivalent was less than 0 D and VA improved with pinhole, a correction factor based on the difference between presenting and pinhole VAs[15] was applied to the lensometry spherical equivalent value to estimate the severity of myopia. If VA did not improve with pinhole, the lensometry spherical equivalent was used to estimate the severity of myopia without using a correction factor. If no corrective lenses were worn and VA improved with pinhole, the eye was classified as unknown (ie, had refractive error but could not be classified as myopic or nonmyopic). If no corrective lenses were worn and VA did not improve (or stayed the same) with pinhole, the eye was classified as nonmyopic.

If presenting VA was 20/50 or worse, retinoscopy was performed. If the spherical equivalent objective refraction was less than 0 D, the eye was classified as myopic. If the spherical equivalent measurement was 0 D or higher, the eye was classified as nonmyopic.

Data from right eyes with a history of cataract surgery were treated as missing values in the analyses.

1999-2004

Although most participants in the 1999-2004 NHANES had refractions, for comparative purposes we classified right eyes as myopic or nonmyopic applying a method as similar as possible to that used in 1971-1972 (Figure 1), with the following differences in 1999-2004. Estimated best VA was obtained from remeasurement of VA aided by a correction determined by the final automated refraction measurements rather than from pinhole VA. The VA was not remeasured with the aid of the autorefractor for eyes with presenting VA of 20/25; if no corrective lenses were worn, these eyes were classified as nonmyopic. Objective refraction was measured by autorefraction, not retinoscopy. Objective refraction values were substituted for lensometry for participants who wore contact lenses (ie, lensometry was not performed on contact lenses). Data from eyes with a history of refractive or cataract surgery were treated as missing values in the analyses.

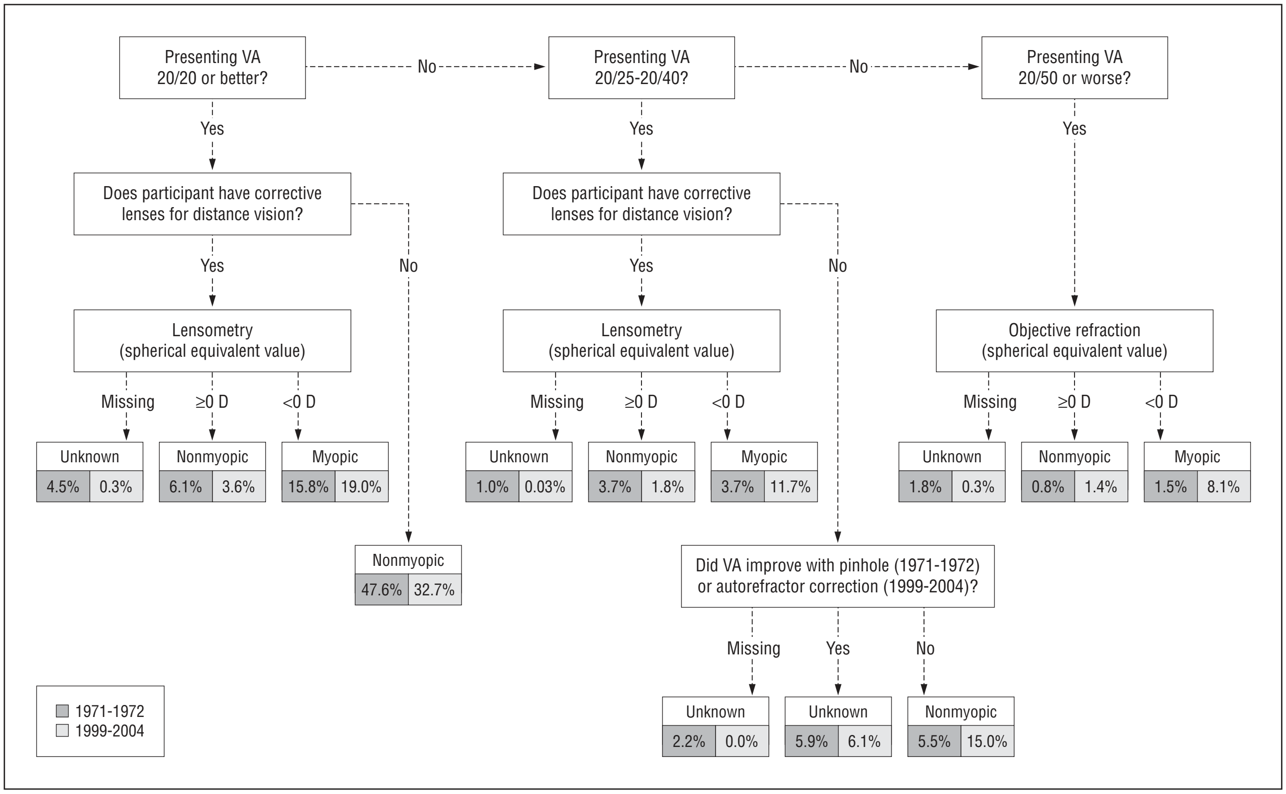

Figure 1. Myopia classification. The percentage of participants in each category is indicated for both 1971-1972 and 1999-2004. Participants with presenting visual acuity (VA) of 20/25 did not have VA remeasured with autorefractor correction in 1999-2004; if they had no corrective lenses, they were classified as nonmyopic. D indicates diopters.

MYOPIA SEVERITY

The severity of myopia was based on the spherical equivalent value (in diopters) obtained from objective refraction or lensometry and adjusted by a correction factor.[15] Myopia severity was classified as in the 1971-1972 article[4]: mild, less myopic than −2.0 D; moderate, −2.0 D to less myopic than −7.9 D; and severe, −7.9 D or more myopic.

STATISTICAL ANALYSES

The NHANES participants were selected based on a multistage probability sample design using oversampling within selected age and race/ethnicity subgroups to estimate prevalence with a specified precision.[16] The selection probabilities are used to compute sampling weights,[17,18] which must be incorporated into analyses to obtain estimates and unbiased standard errors[19,20] reflective of the US population's demographic characteristics. We used SUDAAN version 9.0.0 statistical software (Research Triangle Institute, Research Triangle Park, North Carolina) to compute weighted prevalence estimates.[21]

RESULTS

In the 1971-1972 NHANES, 5282 persons aged 12 to 54 years were examined and 4436 (84.0%) had sufficient information to classify the myopia status of the right eye. Individuals with insufficient data for classification were more likely to wear distance vision correction and to have decreased VA than were those who could be classified.[4]

A total of 9609 black and white participants aged 12 to 54 years participated in the 1999-2004 NHANES examination; of these, 8339 (86.8%) had sufficient information to classify their right eye as myopic or nonmyopic using the 1971-1972 algorithm. Reasons for missing information on myopia status for the right eye included incomplete vision examination data due to lack of time, refusal, or equipment malfunction (n=533), history of cataract surgery (n=22), history of refractive surgery (n=89), missing lensometry data (n=15), and unclassifiable status (as defined in 1971-1972: presenting VA of 20/30-20/40, no corrective lenses, and improvement in VA with an autorefractor aid [n=626]).

Persons with insufficient information for myopia classification as compared with those whose myopia status could be classified were significantly more likely to be female (54.0% vs 50.1%, respectively; $P=.02$), black (19.8% vs 15.0%, respectively; $P=.008$), and aged 45 to 54 years (27.0% vs 24.2%, respectively; $P=.06$).

AGE AND RACE

The prevalence of myopia for individuals aged 12 to 54 years was statistically significantly higher in 1999-2004 than in 1971-1972 (41.6% vs 25.0%, respectively; $P<.001$) (**Table 1**). For black participants, the prevalence of myopia in 1999-2004 was at least twice as high as in 1971-1972 for nearly all age groups; all differences were statistically significant (**Figure 2**). For white participants, the 1999-2004 prevalence rates were 30.3% higher (for those aged 12-24 years; $P<.001$ for those aged 12-17 years and $P=.003$ for those aged 18-24 years) to 80.8% higher (for those aged 25-54 years; $P<.001$ for those aged 25-34, 35-44, and 45-54 years) than the corresponding 1971-1972 rates.

SEX

The prevalence of myopia was statistically significantly higher in 1999-2004 than in 1971-1972 for both females (45.8% vs 27.1%, respectively; $P<.001$) and males (37.4% vs 22.8%, respectively; $P<.001$) (**Table 2** and **Figure 3**).

Table 1. Prevalence of Myopia by Race/Ethnicity and Age in the 1971-1972 and 1999-2004 National Health and Nutrition Examination Survey

Race/Ethnicity and Age, y	Prevalence of Myopia, % (95% CI)		*P* Value
	1971-1972	1999-2004	
Black			
12-17	12.0 (6.6-17.4)	31.2 (28.1-34.2)	<.001
18-24	10.4 (5.4-15.4)	35.2 (31.0-39.4)	<.001
25-34	12.3 (5.3-19.3)	30.8 (25.7-35.9)	<.001
35-44	14.8 (7.2-22.4)	35.6 (31.1-40.1)	<.001
45-54	17.3 (3.1-31.5)	34.3 (28.6-39.9)	.01
Total	**13.0 (9.4-16.6)**	**33.5 (31.0-36.0)**	**<.001**
White			
12-17	25.8 (22.2-29.4)	34.5 (30.8-38.2)	<.001
18-24	29.7 (24.5-34.9)	38.7 (34.5-42.8)	.003
25-34	25.6 (22.0-29.2)	46.3 (42.3-50.4)	<.001
35-44	24.9 (20.3-28.5)	44.1 (40.5-47.8)	<.001
45-54	25.5 (20.9-30.1)	46.2 (42.3-50.1)	<.001
Total	**26.3 (23.9-28.7)**	**43.0 (41.0-45.0)**	**<.001**
Black and white			
12-17	24.0 (20.8-27.2)	33.9 (30.8-37.0)	<.001
18-24	27.7 (23.5-31.9)	38.1 (34.6-41.6)	<.001
25-34	24.2 (21.0-27.4)	44.0 (40.3-47.7)	<.001
35-44	24.5 (20.5-28.5)	42.9 (39.8-46.1)	<.001
45-54	24.8 (20.4-29.2)	44.8 (41.0-48.6)	<.001
Total	**25.0 (22.8-27.2)**	**41.6 (39.8-43.4)**	**<.001**

Abbreviation: CI, confidence interval.

SEVERITY OF MYOPIA

The prevalence of mild myopia (**Table 3** and **Figure 4**) was statistically significantly higher in 1999-2004 than in 1971-1972 (17.5% vs 13.4%, respectively; $P<.001$). The prevalence of moderate myopia was statistically significantly higher in 1999-2004 than in 1971-1972 (22.4% vs 11.4%, respectively; $P<.001$); for individuals aged 25 years and older, the 1999-2004 rates were more than double those of 1971-1972 ($P<.001$). Overall and for individuals aged 18 to 54 years, the 1999-2004 prevalence of severe myopia was higher than that in 1971-1972 (overall: 1.6% vs 0.2%, respectively; $P<.001$); however, no difference was noted for individuals aged 12 to 17 years ($P=.36$) (Table 3).

Table 2. Prevalence of Myopia by Sex and Age in the 1971-1972 and 1999-2004 National Health and Nutrition Examination Survey

Sex and Age, y	Prevalence of Myopia, % (95% CI)		*P* Value
	1971-1972	1999-2004	
Female			
12-17	26.4 (20.8-32.0)	37.0 (33.7-40.2)	<.001
18-24	32.5 (26.3-38.7)	46.4 (41.3-51.6)	<.001
25-34	27.8 (23.0-32.6)	49.1 (44.0-54.2)	<.001
35-44	23.2 (20.0-26.4)	47.4 (43.7-51.2)	<.001
45-54	25.1 (20.7-29.5)	45.8 (41.1-50.4)	<.001
Total	**27.1 (24.7-29.5)**	**45.8 (43.2-48.3)**	**<.001**
Male			
12-17	21.7 (17.5-25.9)	30.9 (27.0-34.8)	<.001
18-24	22.5 (17.3-27.7)	29.7 (25.8-33.6)	.01
25-34	20.2 (15.8-24.6)	38.9 (34.5-43.4)	<.001
35-44	26.1 (18.7-33.5)	38.4 (34.2-42.5)	.002
45-54	24.4 (19.2-29.6)	43.8 (39.1-48.6)	<.001
Total	**22.8 (19.8-25.8)**	**37.4 (35.6-39.3)**	**<.001**

Abbreviation: CI, confidence interval.

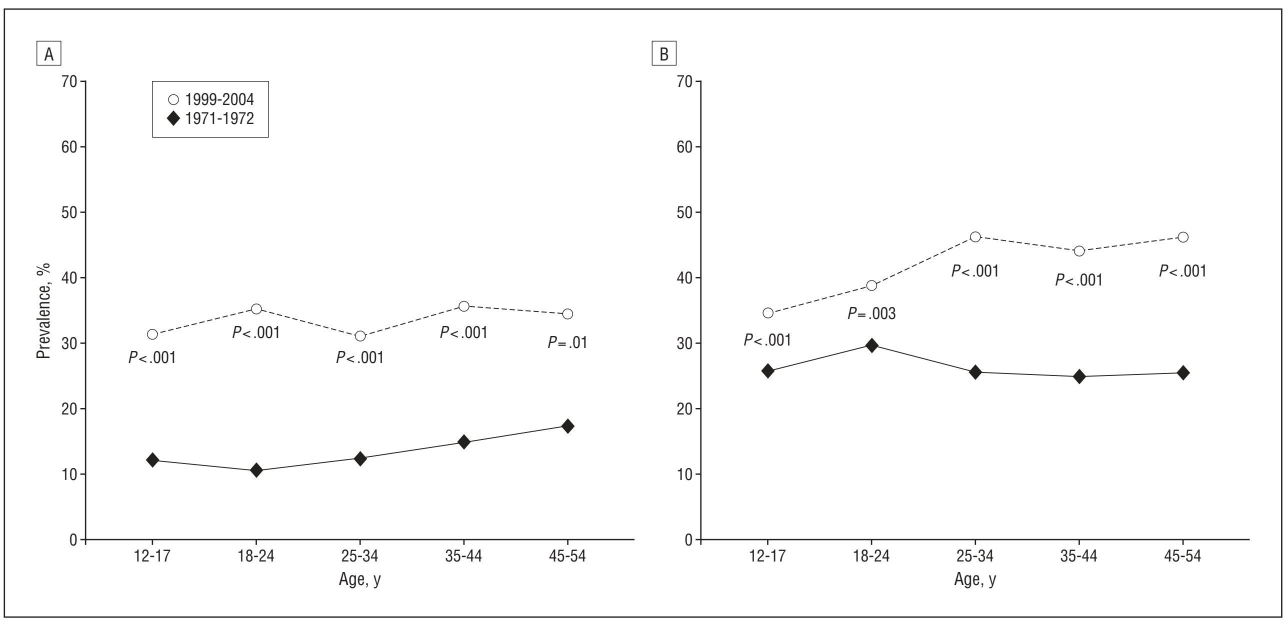

Figure 2. Prevalence of myopia among black participants (A) and white participants (B), comparing National Health and Nutrition Examination Survey data from 1971-1972 vs 1999-2004. *P* values are in comparison with the 1971-1972 data for the same age group.

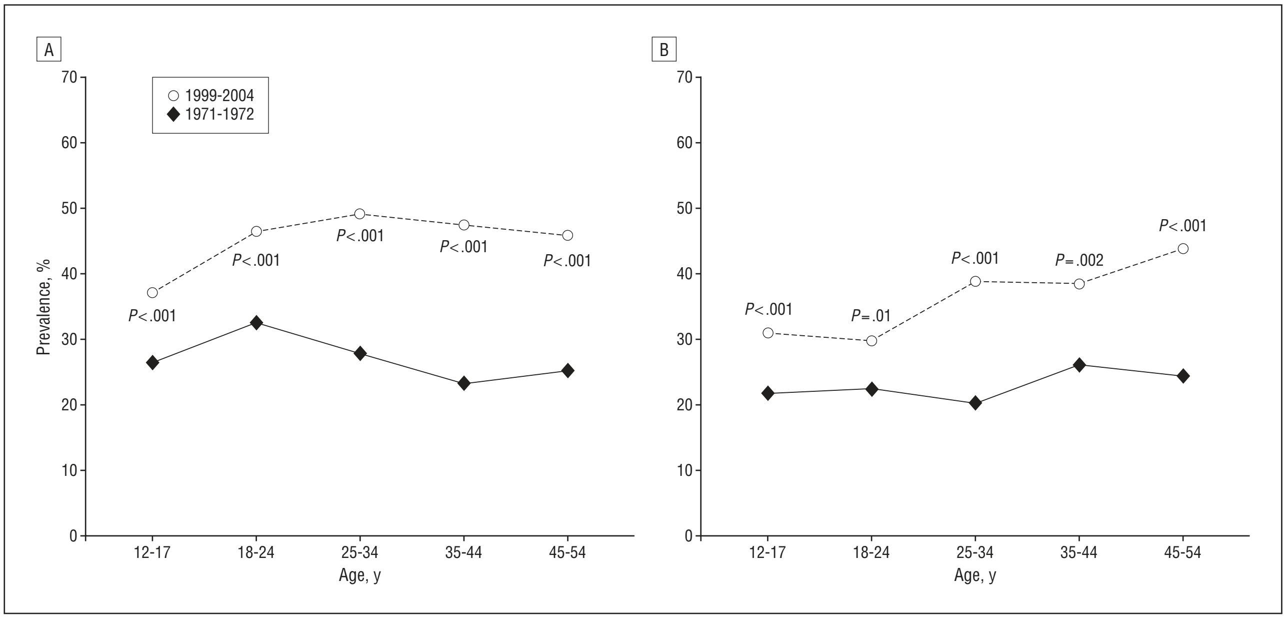

Figure 3. Prevalence of myopia among females (A) and males (B), comparing National Health and Nutrition Examination Survey data from 1971-1972 vs 1999-2004. *P* values are in comparison with the 1971-1972 data for the same age group.

Table 3. Prevalence of Myopia by Severity and Age in the 1971-1972 and 1999-2004 National Health and Nutrition Examination Survey

Myopia Severity, and Age, y[a]	Prevalence of Myopia, % (95% CI) 1971-1972	1999-2004	*P* Value
All levels			
12-17	24.0 (20.8-27.2)	33.9 (30.8-37.0)	<.001
18-24	27.7 (23.5-31.9)	38.1 (34.6-41.6)	<.001
25-34	24.2 (21.0-27.4)	44.0 (40.3-47.7)	<.001
35-44	24.5 (20.5-28.5)	42.9 (39.8-46.1)	<.001
45-54	24.8 (20.4-29.2)	44.8 (41.0-48.6)	<.001
Total	**25.0 (22.8-27.2)**	**41.6 (39.8-43.4)**	**<.001**
Spherical equivalent >–2.0			
12-17	11.1[a]	16.9 (14.8-19.0)	<.001
18-24	11.7[a]	16.8 (13.8-19.8)	.008
25-34	13.1[a]	17.0 (14.8-19.3)	.007
35-44	15.9[a]	15.9 (13.5-18.2)	.51
45-54	15.8[a]	20.6 (18.1-23.1)	.003
Total	**13.4[a]**	**17.5 (16.2-18.9)**	**<.001**
Spherical equivalent ≤–2.0 to >–7.9 D			
12-17	12.5[a]	16.7 (14.4-19.0)	.005
18-24	15.8[a]	19.9 (16.3-23.4)	.05
25-34	10.7[a]	24.7 (21.6-27.8)	<.001
35-44	8.4[a]	24.6 (21.8-27.4)	<.001
45-54	8.9[a]	23.1 (19.3-26.8)	<.001
Total	**11.4[a]**	**22.4 (20.7-24.1)**	**<.001**
Spherical equivalent ≤–7.9 D			
12-17	0.4[a]	0.3 (0.1-0.6)	.36
18-24	0.3[a]	1.4 (0.6-2.3)	.02
25-34	0.3[a]	2.2 (1.2-3.2)	.004
35-44	0.2[a]	2.4 (1.5-3.3)	<.001
45-54	0.0[a]	1.1 (0.6-1.7)	.002
Total	**0.2[a]**	**1.6 (1.3-2.0)**	**<.001**

Abbreviations: CI, confidence interval; D, diopters.
[a] *P* values were computed using the 1999-2004 standard error for both 1971-1972 and 1999-2004.

YEARS OF FORMAL EDUCATION

The prevalence of myopia in persons with 12 or more years of formal education (**Table 4** and **Figure 5**) was 25.7% to 59.8% higher in 1999-2004 than in 1971-1972 ($P < .05$).

DISTRIBUTION OF SPHERICAL EQUIVALENT

For a spherical equivalent of –2.0 or more myopic, the 1999-2004 prevalence exceeded that of 1971-1972 (**Figure 6**A).

COMMENT

The goal of this study was to examine whether the prevalence of myopia in the United States had changed during the 30 years between the 1971-1972 and 1999-2004 NHANES. To allow a valid comparison between the 2 surveys, the method for diagnosing myopia in the earlier study was applied to data from the later study. Because the estimates of myopia prevalence reported here were mainly derived for comparison purposes, they are not intended as a substitute for our previously reported values,[7] which were based on objective refractions of the 1999-2004 cohort.

We found that the prevalence of myopia was 66.4% higher among participants aged 12 to 54 years in the 1999-2004 NHANES than in the 1971-1972 NHANES (41.6% vs 25.0%, respectively; $P < .001$). Differences in prevalence were particularly striking for black participants, for whom the 1999-2004 estimates were more than double the rates of the earlier study. In white participants, the 1999-2004 rates were 63.5% higher than those in 1971-1972. Males and females had prevalence estimates in 1999-2004 that were 64.0% and 69.0% higher, respectively, than

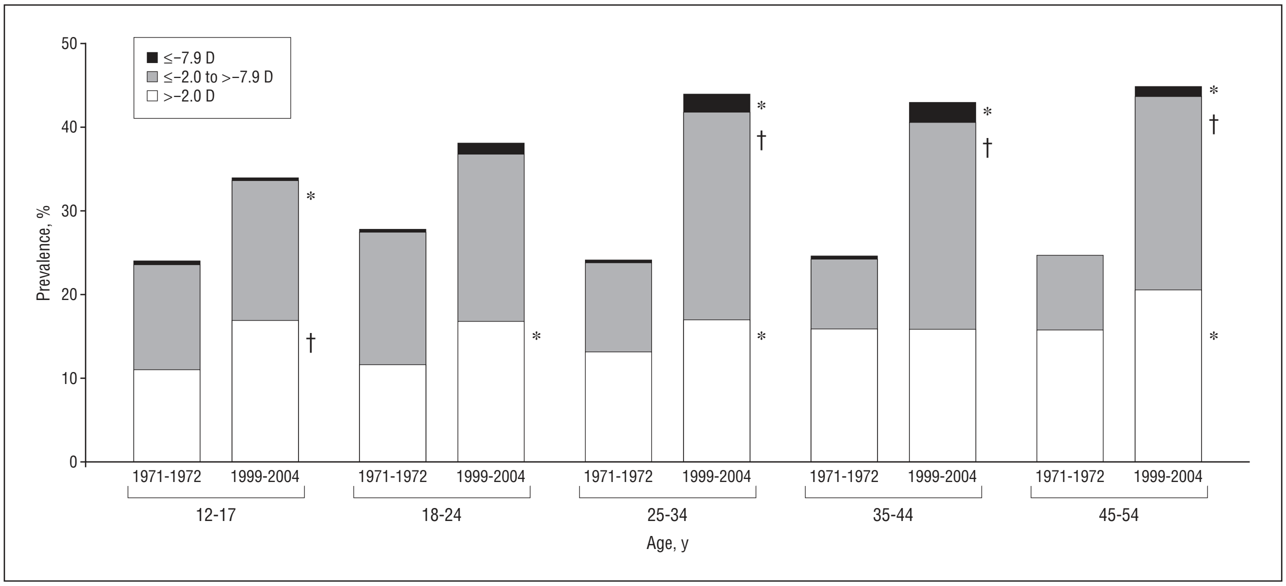

Figure 4. Prevalence of myopia by severity (spherical equivalent in diopters [D], right eye), comparing National Health and Nutrition Examination Survey data from 1971-1972 vs 1999-2004. *$P<.01$ for each severity category when comparing the prevalence in 1971-1972 vs 1999-2004. †$P<.001$ for each severity category when comparing the prevalence in 1971-1972 vs 1999-2004.

Table 4. Prevalence of Myopia by Age in Persons With 12 or More Years of Formal Education in the 1971-1972 and 1999-2004 National Health and Nutrition Examination Survey

	Prevalence, % (95% CI)		
Age, y	**1971-1972**	**1999-2004**	***P* Value**
12-17	NA	NA	NA
18-24	31.4 (24.9-37.9)	42.6 (37.1-48.0)	.004
25-34	32.3 (23.7-40.9)	51.6 (47.0-56.3)	<.001
35-44	39.3 (30.1-48.5)	49.4 (45.4-53.4)	.02
45-54	39.5 (29.7-49.3)	51.8 (47.1-56.6)	.01

Abbreviations: CI, confidence interval; NA, not applicable.

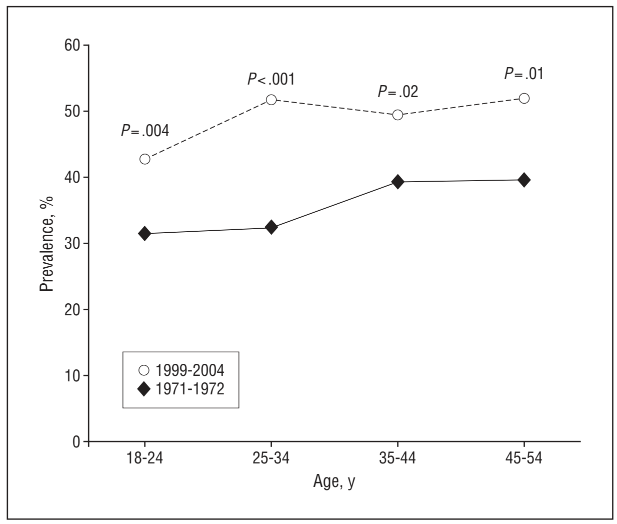

Figure 5. Prevalence of myopia in persons with 12 or more years of formal education, comparing National Health and Nutrition Examination Survey data from 1971-1972 vs 1999-2004. *P* values are in comparison with the 1971-1972 data for the same age group.

those in 1971-1972. The prevalence of mild myopia was significantly higher in the later study than in the earlier study (17.5% vs 13.4%, respectively; $P<.001$), as was the prevalence of moderate myopia (22.4% vs 11.4%, respectively; $P<.001$). The prevalence of severe myopia is low but apparently increased between the 2 study periods (0.2% in 1971-1972 vs 1.6% in 1999-2004; $P<.001$).

The difference between the 1971-1972 and 1999-2004 prevalence rates was greater for black participants than for white participants. Black participants surveyed in 1971-1972 may have had less access to educational opportunities than white participants and consequently experienced less exposure to near work (a risk factor for myopia[22]). As racial inequities in educational opportunities decreased, near-work exposure may have increased relatively more in black participants than in white participants.

Previous studies have reported associations between years of formal education and myopia.[5,23-25] The higher 1999-2004 prevalence rates might be explained by an increased proportion of persons with 12 or more years of formal education. However, among persons with 12 or more years of formal education, the differences in prevalence between 1999-2004 and 1971-1972 persisted (25.7%-59.8% higher) and remained statistically significant. It is possible that the years of education increased between 1971-1972 and 1999-2004 among those with 12 or more years of formal education. We were unable to explore this hypothesis because the 1999-2004 NHANES released education data only in a categorical format.

Previously[7] we classified subjects as myopic based on worse-eye spherical equivalent refraction using a variety of cutoff values to allow comparisons with results from the Eye Diseases Prevalence Research Group.[26] In the current study, we classified subjects as myopic based on any degree of negative spherical equivalent (based on lensometry or refraction) in the right eye. This criterion, al-

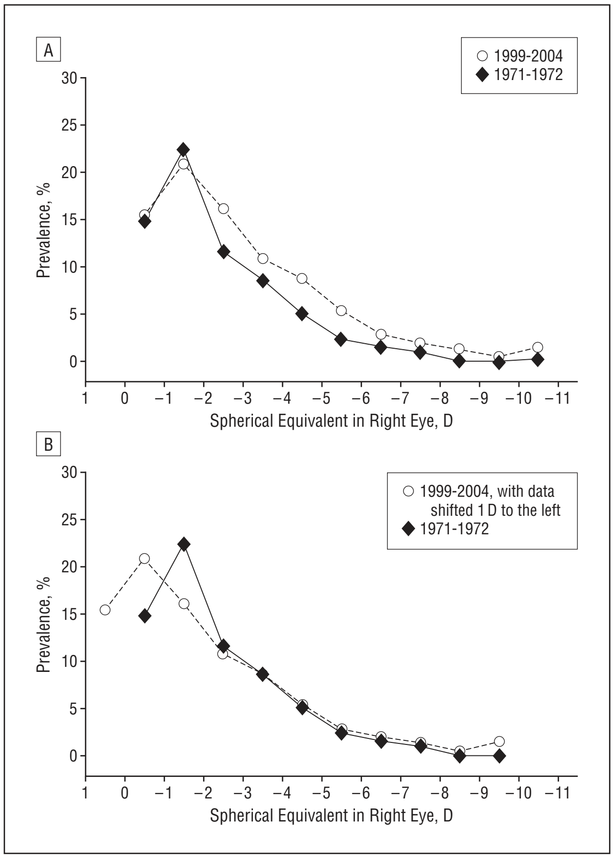

Figure 6. The distribution of spherical equivalents in the National Health and Nutrition Examination Survey data from 1971-1972 and 1999-2004 for myopic eyes is shown (A), and shifting the 1999-2004 distribution by 1 diopter (D) to the left makes it nearly identical to the 1971-1972 distribution (B).

though not optimal in terms of clinical significance and potential for misclassification, was chosen to allow comparisons with the published 1971-1972 NHANES estimates.

In 1971-1972, 15% of participants in the vision examination could not have their refractive status classified[4] because of incomplete vision examination information (9%) or because presenting VA was 20/25 to 20/40 and corrective lenses were not worn (6%). Compared with participants whose refractive status could be classified, those whose refractive status could not be classified were more likely to wear distance vision correction and have poor presenting VA[4]; the effect of these imbalances would result in a 1% underestimate of myopia prevalence,[4] insufficient to account for the differences observed in this study. In 1999-2004, females were more likely than males to be nonparticipants in the vision examination and have myopia (45.8% vs 37.4%, respectively). Accounting for higher rates of nonparticipation by females would increase the overall prevalence estimate for 1999-2004; thus, nonparticipation bias is not a likely explanation of our results. Systematic bias in study participation based on myopia status is unlikely because the eye examination and interview were only a very small part of the comprehensive NHANES.

The 1971-1972 study had a limited ability to categorize the refractive status of persons who presented with VA of 20/25 to 20/40 and had no corrective lenses; if VA improved with pinhole testing, the status was classified as unknown because the type of refractive error could not be determined. For comparability, data from participants in the 1999-2004 NHANES with presenting VA of 20/30 to 20/40 were handled similarly. This probably resulted in underestimates of myopia prevalence in both studies because participants (especially younger participants) with decreased distance presenting VA and no corrective lenses were more likely to be myopic. In 1999-2004, 75.1% of participants with presenting VA of 20/25 to 20/40, no corrective lenses, and improved vision with autorefraction correction—classified as unknown—actually were myopic based on autorefraction values (which, emulating the 1971-1972 methods, were not used for classification).

In the 1999-2004 NHANES, people with presenting VA of 20/25 did not have a second VA measurement aided by the autorefraction results; if they did not have corrective lenses, we classified them as nonmyopic. If we had instead classified them as unknown, the myopia prevalence estimates for 1999-2004 would have been still higher.

We are unaware of any studies comparing refraction values obtained by an autorefractor vs retinoscopy or comparing VA assessed using the autorefractor's chart vs standard VA charts.[27] Systematic bias in the 1999-2004 measurement of spherical equivalent is a possible explanation for our results. A 1-D shift of the 1999-2004 spherical equivalent distribution would be required to eliminate the discrepancy between the 1999-2004 and 1971-1972 surveys (Figure 6B). This degree of systematic mismeasurement seems highly unlikely.

Several previous studies documented an increased prevalence of myopia over time in specific populations.[5,28-30] A review[6] concluded that increasing levels of education combined with possible genetic susceptibility are likely to be responsible for the reported increases in the prevalence of myopia.

Strengths of our study include the nationally representative composition of both NHANES study populations, the standardized method used in the vision examinations, and our use of a similar method to classify eyes as myopic in the 2 surveys. In cases where the method could not be made identical, we were able to estimate the effects on the prevalence estimates of different methods of classification. We could not identify any source of misclassification (Figure 1) that could account for the differences observed between 1971-1972 and 1999-2004. Altering our assumptions caused the 1999-2004 estimates of myopia to increase and differ even more from the 1971-1972 data.

Although myopia can be treated relatively easily with corrective lenses, it engenders substantial expenditures on a population basis owing to its high prevalence. If 25% of those aged 12 to 54 years had myopia, the associated annual cost would be more than $2 billion[31,32]; an increase in prevalence to 37% would increase the cost to more than $3 billion. The question of whether myopia prevalence is increasing is therefore important to health planners and policy makers. Identifying modifiable risk factors for the development of myopia could lead to the development of cost-effective interventional strategies.

Submitted for Publication: November 5, 2008; final revision received April 7, 2009; accepted May 31, 2009.
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Author Contributions: Dr Vitale had full access to all of the data in the study and takes full responsibility for the integrity of the data and the accuracy of the data analysis.
Financial Disclosure: None reported.
Funding/Support: The NHANES is sponsored by the National Center for Health Statistics, Centers for Disease Control and Prevention. Additional funding for the NHANES Vision Component was provided by Intramural Research Program Z01EY000402 of the National Eye Institute, National Institutes of Health.
Role of the Sponsor: The National Center for Health Statistics provided funding support for the NHANES and was involved in the design, management, and conduct of the study and in data collection but was not involved in the analysis or interpretation of the vision examination study results or in the preparation, review, or approval of the manuscript. The National Eye Institute provided funding support for the vision examination and was involved in the design and conduct of the vision component, in the collection, analysis, and interpretation of the vision data, and in the preparation, review, and approval of the manuscript before submission.
Additional Contributions: We thank the staff of the National Center for Health Statistics, Centers for Disease Control and Prevention, especially Brenda Lewis, BS, ASCP, MPH, for expert assistance with all technical aspects of the vision component; the staff at Westat, Inc, especially Kay Apodaca, BA, MSW, and Beryl Carew, MPH, BN, for their role with data collection activities; Susan Corwin, CO, COMT, for training field staff; and the participants in NHANES, without whose time and dedication this study would not have been possible.

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