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The Multifactorial Etiology of Myopia

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ABSTRACT

Myopia, more commonly known as nearsightedness, affects an enormous percentage of the adolescent population, but its causes are not extremely well quantified. While it has been established that myopia is caused by a combination of genetic and environmental factors, this study aimed to look at both factors together and determine which has the greater influence on myopia, or if they are both equally significant. This study addressed this through a mixed-method correlational design, which included a primary questionnaire as well as secondary interviews, both of which were based on the works of Huang et al. and also Wang and Bi. A total of 122 responses were collected and used, and regarding biological factors, there was a moderate-strong correlation between the presence of myopia in a family and the presence of myopia in an individual ($r(122) = .65$, $p < .001$). In environmental factors, there was a moderate-weak correlation between near-work and myopia ($r(1122) = .23$, $p = .04$). The results indicated that biological factors play a larger role in the development of myopia than environmental factors do. These conclusions indicate that, when attempting to predict myopia in an individual, the presence of it in one's family is more important than the time they spend performing near-work activities.

Introduction

According to the CDC, in 2019, almost 45% of all children aged twelve and up needed some form of corrective lenses, and every year this number increases. Looking at the causes behind this issue, it is important to note that the primary reason for a need for glasses is a refractive error in the eye (Karakus). Refractive errors occur when the eye's curvature results in an imperfect refraction of light into the eye, causing objects to appear blurry when far or close, depending on the exact error. Of all refractive errors, myopia, more commonly referred to as nearsightedness, is the most common and is the main cause behind the need for glasses in an individual (WHO, 2013). Examining the causes behind myopia, it has been found that it has a multifactorial etiology, which means that its development and progression is the result of two or more separate factors. These factors have been found to include genetics, since myopia tends to run in families and is associated with several genetic loci, but also include environmental pressures, since large amounts of near-work activity have been significantly associated with an increase in nearsightedness (Wolffsohn, 2019). Therefore, the purpose of this study is to determine the individual relationship between each factor (biological and environmental) and myopia. Currently, due to the largely equal number of studies on each factor, the results are expected to show that both factors have similar or equal interactions with myopia.

Literature Review

Purpose

This study aims to quantify the exact effect of biological and environmental factors on myopia in comparison to each other. Therefore, the sources examined on the topic will be divided into sections looking at biological factors and environmental factors. Additionally, an exact definition of what constitutes "biological factors" and what constitutes "environmental factors" will be necessary in order to be able to quantify the effect of each on myopia.

Environmental factors

Near-Work

Although multiple studies have been used to prove that performing near-work activities results in myopic progression, the term "near-work" must be defined. According to Huang et al. (2015), who performed a study to measure the exact effect of near-work on childhood myopia, near work is defined as, "activities done at short working distance such as reading, studying (doing homework, writing), computer use/playing video games, or watching TV, etc." Additionally, this source makes use of information from Morgan and Rose, a study regarding the heritability of myopia. While this study focuses on the genetics behind myopia, it begins by stating that myopia has a diverse etiology, and that it is associated with education and reading (Morgan & Rose, 2005). The Huang et al. study credits this source with the theory that myopia has a multifactorial etiology, since the Morgan and Rose study itself mentions that the diverse etiology of myopia is probable but in need of further evidence before it is confirmed. Back to Huang et al., the researchers determined that, in children, computer use was positively associated with myopic increase. Similarly, other studies such as a study regarding the effect of smartphone overuse on myopia, corroborate this result. For example, in Enthoven et al. (2020), which aimed to determine the relationship between forms of near work and myopia, it was found that both computer use and reading books had a significant effect on myopia in children. Additionally, in a study performed by Wang et al. (2020), the results of 14 studies regarding smartphone use and myopia were pooled to determine the larger correlation between the two variables. The analysis revealed that, in adults, there was little to no correlation between smartphone usage and myopic progression. However, the analysis also revealed that in children ages 10-19, when myopic development is most common, there was a weak, but statistically significant ($p < 0.01$) correlation between smartphone usage and myopia. Therefore, there is a clear link between most sources regarding near-work and myopia, and although each source attempts to quantify the effect of a specific type of near-work, for example reading from a book, using a computer, or using a smartphone, the common analysis between these sources is that all forms of near work have some correlation with myopic development, especially in children.

Outdoor Exposure

However, the term "environmental factors" does not refer to near-work alone, as almost all other activities that do not constitute near-work, for example playing a sport or constructing a building, also fall under the blanket of environmental factors that can impact myopic development. Therefore, it is important to note another finding on the effect of far-work and outdoor exposure on myopic development. To further assess the impact of environmental factors as a whole on myopia, Enthoven et al. (2020) found that the combined effect of various forms of near-work on myopia can actually be combated by spending similar amounts of time outdoors in the sun, performing activities that do not constitute near-work. Therefore, exposure to the sunlight is a common activity that may combat myopic development and progression and is an important facet in the list of environmental factors behind the complex mechanics of myopia.

Biological Factors

Parental Myopia and Heritability

Although the term "biological factors" refers to an extremely wide range of complex genetic mechanisms that have not yet been entirely understood, a large indicator of myopia is the presence of myopia in that individual's parents (parental myopia). Huang et al, which included questions regarding the presence of parental myopia as a part of their methodology, stated that the biggest biological risk factor for myopia in an individual was having at least one parent with myopia, which increased the potential for myopia in an individual by 83.1%. The exact methodology used by Huang et al. consisted of the use of a survey questionnaire to assess the presence of myopia in one's family. Likewise, Wang and Bi, which looks at the heritability of myopia, utilized a similar method to Huang et al. and found that the presence of myopia in an individual's first-degree family increased the risk for myopia in an individual. Wang and Bi. also stated that, apart from the presence of myopia in one's parents, the severity of the parental myopia also had a small effect on the severity of an individual's myopia. Additionally, while Huang et al. only looks at parental myopia as a biological risk factor, Wang and Bi define a wide variety of biological factors that influence myopia. For example, they state parental myopia and familial myopia as risk factors, but also parental severity, and also race as various biological factors that impact myopia. However, one source identified by both Wang and Bi, as well as Huang et al. as being foundation to their work is Dirani et al. (2006), which was stated to be one of the first studies to confirm the theory that myopia was influenced by genetics. Contrastingly, this source utilizes a completely different method from both Wang and Bi, and also Huang et al.; rather than using a questionnaire as a part of its method, this study looked at 1224 twins (twin study) to see if myopia was passed between twin siblings. Although the results differ slightly between sexes, the study found that the heritability of similar eye shapes, lengths, and focuses between twins was, on average, 93%, suggesting that myopia was heritable. Despite utilizing entirely different methods, the findings of both original sources align with those of Dirani et al., which come in synthesis to suggest that biological factors, outside of pure genetics, include the presence of myopia in siblings and parents, and also the severity of that myopia.

Demographics

Since myopia is affected by biological factors in addition to environmental factors, myopia is often passed through generations of a certain ethnicity and thus result in specific myopic trends for each ethnicity. This concept was studied in Jones-Jordan et al., which aimed to determine the differences in myopic progression between different ethnicities and between sexes. The study found that, comparatively, individuals of Asian ethnicity generally have higher rates of myopia, as well as faster myopic progression. Regarding sex, the results of both Jones-Jordan et al., as well as Huang et al., state that there, in myopic development and progression, there was no significant difference between males and females.

Gaps

However, while all of the above sources contribute to the knowledge on the causes of myopia, one topic that all fail to address is whether environmental factors or biological factors have the greater influence on myopia. The literature confirms that both do affect myopia, but the gap in such knowledge is which factor has the greater impact. Thus, the methodology of this study should be constructed in a manner that looks at both factors separately, then an analysis and comparison of the two would reveal which is more significantly associated with myopia. The factor with the largest correlation with myopia would most likely indicate a stronger relationship with it compared to the other.

Methods

The goal of this research is to determine whether environmental factors that affect myopic development, which include performing near-work activity, or biological factors, which consist mainly of heritable genetic components, have a greater influence on the development of myopia in an individual. This paper follows a mixed-method correlational method and aligns most closely with the methodology of Wang and Bi (2021), which researched familial aggregation and heritability of myopia, and consisted of an eye-screening for each participant to determine eye prescription, and later a questionnaire that would ask the participants about whether or not their siblings or parents also suffered from myopia, as well as the severity of their myopia. Additionally, the foundational work of Huang et al. (2019), was crucial to the development of the researcher's methodology. This study aimed to determine the influence of parental myopia on the development of myopia in an individual. It utilizes a survey extremely similar to that of Wang et al, however it also includes information regarding demographics, as well as environmental factors such as time spent reading books and using electronic devices.

Population

Data was collected from Calabasas High School, a large, co-ed, high-performing public high school in California, ranging in grades 9-12, with a population of about 2,000 students. The school is sub-average in terms of ethnic diversity, with a student body that is 78.5% White, 9% Latinx, 5.5% Asian, and 5% African American. The population is of above average socioeconomic status, with a comparatively high income in relation to other high schools in California, and with only 10.6% of the school population being a part of the Free/Reduced Lunch program, which aims to provide students of lower socioeconomic status with discounted or free nourishment.

Sample Selection

A stratified random sampling method was used, with participants consisting of students enrolled in a Social Science course. Social Science courses included Freshman Seminar, World History P, European History AP, US History P, US History AP, American Government P, and American Government AP. This stratum was chosen to ensure maximum representation of the student population at Calabasas High School as Social Science courses are required throughout all four years of high school in order for students to be eligible for graduation. Additionally, this population is ideal in replicating the methods used in Wang and Bi, especially since myopic development is peak within ages 12-19, and the age range of this population is ages 14-18. (Gryzbowski et al., 2020). This selection method resulted in all members of the targeted population being equally likely to be chosen. Through this process, 129 students were identified to participate in the study. Due to the nature of some responses in the free-response portions of the survey, as well as lack of a parent consent, 7 responses were excluded from data analysis. Additionally, through stratified random sampling, two survey respondents, who both had myopia (prescription underneath -1.00D) and agreed to a follow-up questionnaire, were identified to participate in an interview.

Implementation

Implementation of the surveys to the sample population involved sharing the link to participate in the survey via the Google Classroom of each Social Science course. Surveys were administered using Google Forms. Survey data was collected over a two-week period, in which students were able to complete the survey online at any time. Survey data was analyzed using Google Sheets, as well as an online Pearson Correlation Coefficient calculator. After the two week period had passed, two participants were chosen through a lottery to participate in an interview. Interviews were conducted a single week after survey data was collected. Interview participants were emailed a week prior to the interview itself, confirming that they agree to participate in an interview. Interviews were conducted using the web-based video telephony system Zoom.

Measure

Instruments included a survey, of which certain participants were chosen to be interviewed for further depth on the answers they had given in the survey. The survey consisted of 14 questions, and included an informed consent form (Appendix A) that had to be signed by the participant, as well as their parent/guardian if the participant was under the age of 18, before the participant would be able to complete the survey. While survey questions were based on the works of Wang and Bi, as well as Huang et al., questions are not identical to those used in said foundational sources and were either modified to better fit the selected sample. The survey had settings enabled that did not allow participants with emails that did not match the Calabasas High database from answering, ensuring that the sample was limited to the student body alone. The survey was divided into four sections: demographics, personal experience with myopia, time spent on near/far work activity, and familial experience with myopia. List of survey questions and their source are listed below in Table 1.

Table 1. Survey questions with their measurement scale and source

Question	Measurement Scale	Source
Demographics		
How old are you?	14, 15, 16, 17, and 18 years	Self-Defined
What gender do you identify with?	Male, Female, Non-Binary, Agender, Prefer not to say, Other	Self-Defined
Are you of Hispanic or Latino origin?	No, Mexican/Mexican American, Puerto Rican, Cuban, Another, Prefer not to say	Huang et al.
What race do you identify with?	American Indian or Alaska Native, Asian, Black or African American, White, Native Hawaiian Islander or other Pacific Islander, Prefer not to say	Huang et al.
Personal Experience with Myopia		
Do you suffer from myopia?	Yes, No, I don't know	Huang et al.
Do you currently wear corrective glasses and/or contact lenses?	Yes, No, I don't know	Huang et al.
If possible, state your eye prescription.	Free-Response	Huang et al.
Time Spent on Near/Far Activity		
How many hours daily do you spend on small-screen sized devices such as tablets and smartphones?	Free Response	Huang et al.
How many hours daily do you spend on larger-screened devices such as laptops, computers, and television?	Free Response	Huang et al.
How many hours daily do you spend reading from non-digital objects such as books or newspapers?	Free Response	Huang et al.
How many hours daily do you spend outside, with direct contact to the sun's light?	Free Response	Huang et al.

Familial Experience with Myopia		
Are any of your parents myopic?	Yes, No, I don't know	Wang and Bi
What is the severity of your parent's myopia?	Mild (1), Moderate-Mild (2), Moderate (3), Moderate-Severe (4), Severe (5)	Wang and Bi
How many people in your family suffer from myopia?	Free-Response	Wang and Bi

Additionally, as previously mentioned, two participants were selected for an interview. While the interviews were not directly based on any foundational source, they mimicked the survey which, in turn, was derived from multiple studies. The purpose of the interviews was to add specificity to the survey data, as well as to provide the researcher with qualitative data. Interview protocol consisted of five questions, which are listed below in Table 2.

Table 2. Interview Protocol

Interview Protocol	
1	Restate whether or not you are myopic, and if so, what your eye prescription is.
2	Restate how many of your parents have myopia?
3	State specifically what each of your parent's eye prescriptions are.
4	State how many siblings you have and how many of your siblings have myopia.
5	State specifically what each of your sibling's eye prescriptions are.

Results

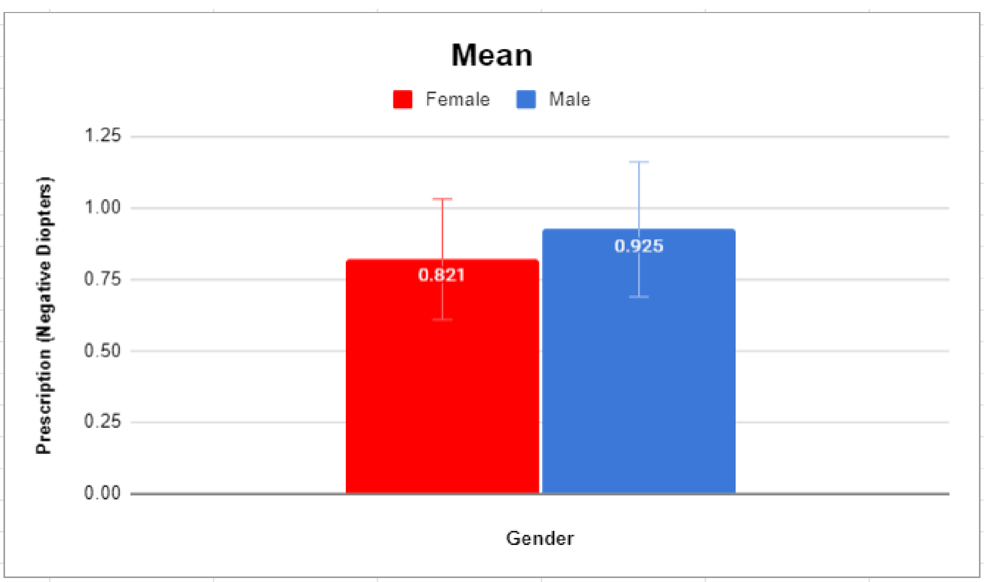

Figure 1. Average prescription of participants based on gender

Regarding gender, 62 participants identified as female, and 60 participants identified as male. The table above shows the average eye prescriptions in negative diopters for each gender, along with error bars representing the standard error of the mean (Figure 1).

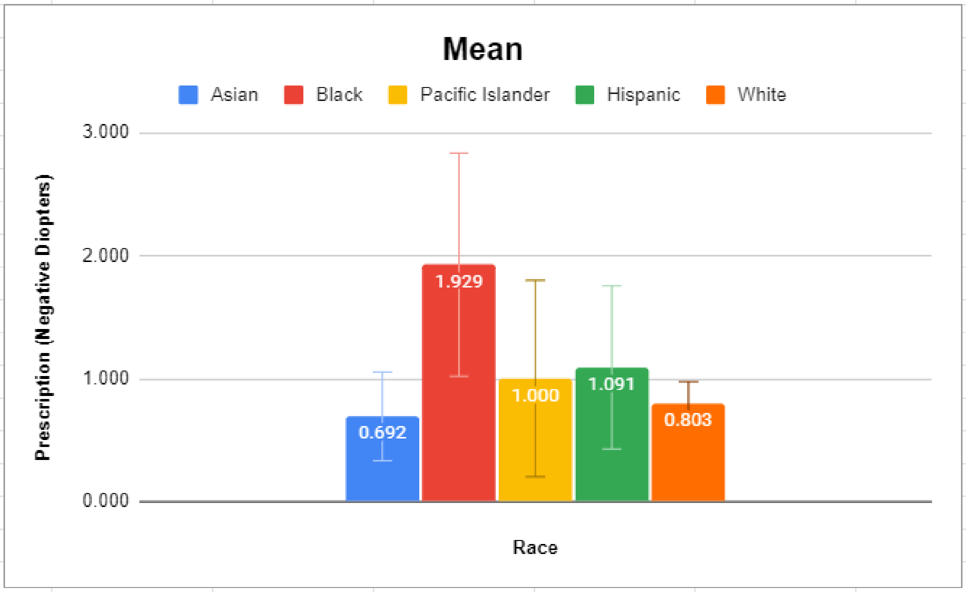

Figure 2. Average prescription of participants based on race

The 122 participants had the following ethnic breakdown: 10.7% Asian, 5.7% African/African American, 1.6% Hawaiian or Pacific Islander, 9% Hispanic or Latinx, and 73% White. The table above presents the mean prescriptions for each ethnicity along with the standard error of the mean represented as error bars (Figure 2).

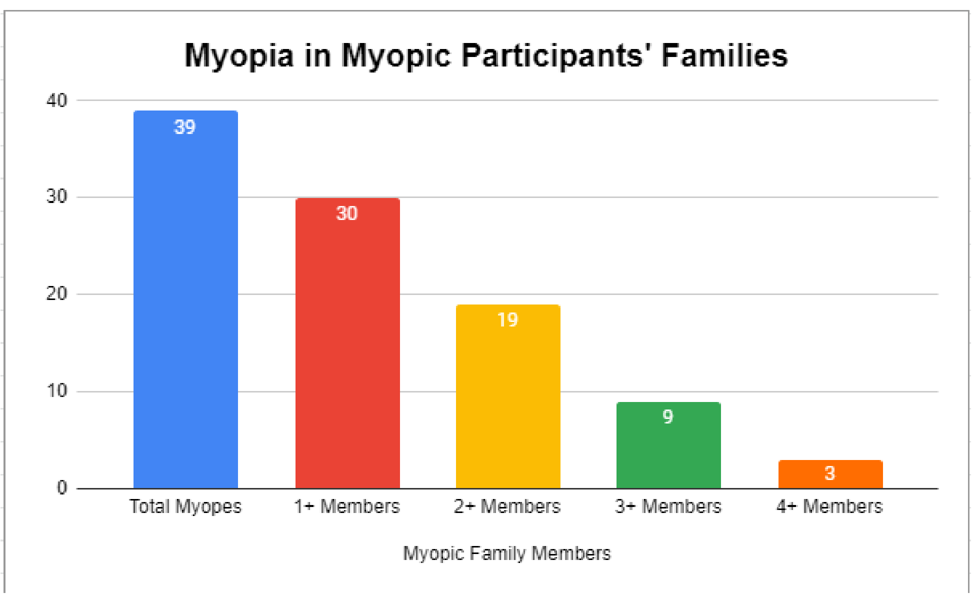

Figure 3. Number of myopes with myopic family members

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Of the 122 participants surveyed, less than 25%, or exactly 39 participants actually suffered from myopia and required corrective lenses. The graph above shows the number of myopic family members in participants who suffered from myopia themselves (Figure 3).

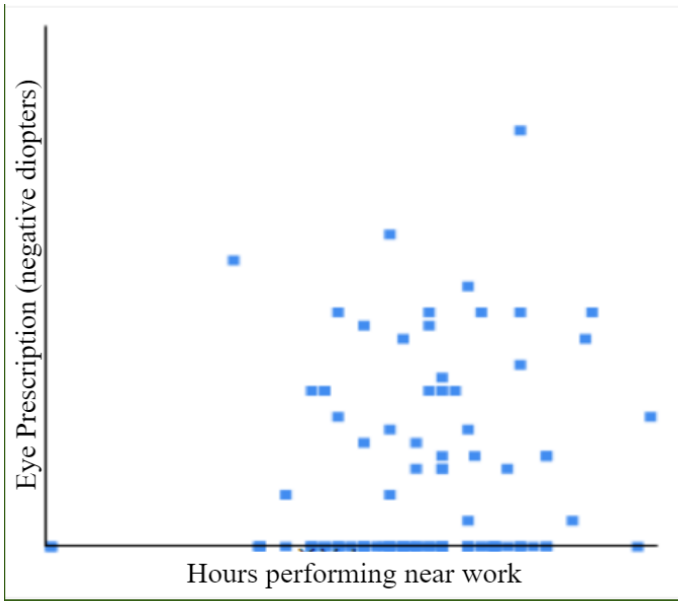

Figure 4. Correlation between eye prescription and hours of near work

The reworked number of hours each participant spent performing near-work was plugged into the Pearson Correlation Coefficient along with their individual prescriptions to produce the graph above (Figure 4). This data is the result of 120 responses, and the final r-value that this graph represents is 0.23 ($p = 0.04$).

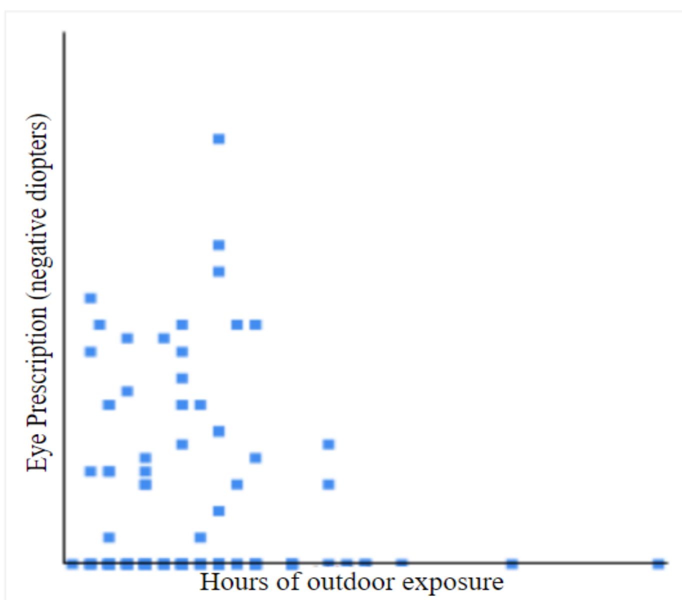

Figure 5. Correlation between eye prescription and hours of outdoor exposure

This graph depicts the relationship between hours of exposure, outdoors, to sunlight compared to individual eye prescription (in negative diopters). After utilizing the Pearson Correlation Coefficient, the above graph was created (Figure 5) with the exact r-value calculated to be -0.18 (p = .37).

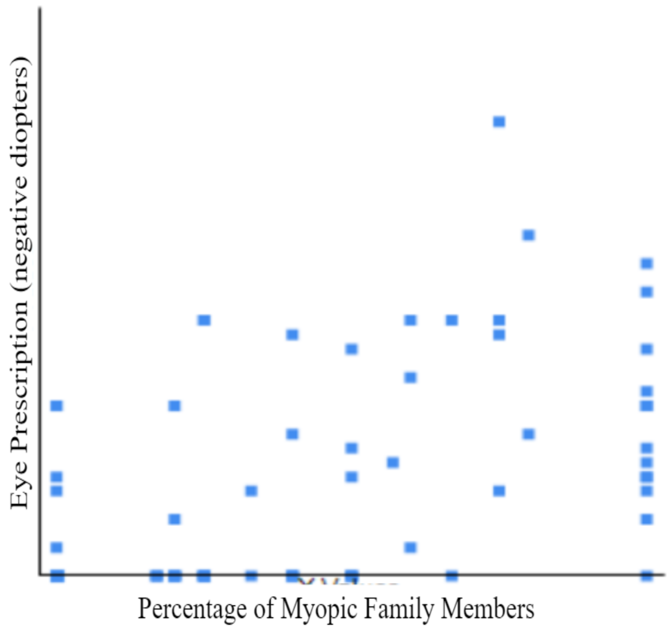

Figure 6. Correlation between eye prescription and percentage of myopic family members

This graph represents the correlation between the presence of myopia in a family versus in an individual and contains the data from a total of 120 responses. The exact values used were the exact eye prescription of the individual participant, and then the percentage of first-degree family members who had myopia. This value was expressed as a fraction, for example, three myopic family members in a family of four would be expressed as 0.75. The above graph was produced (Figure 6), which depicts an r-value of 0.65 ($p < 0.01$).

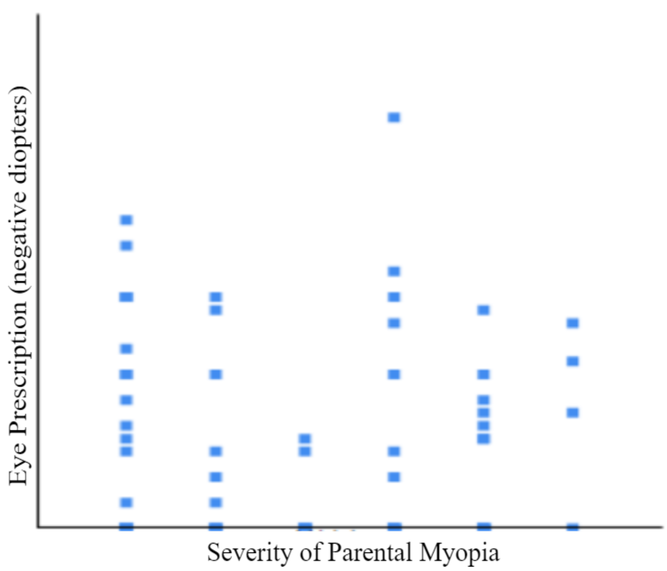

Figure 7. Correlation between eye prescription and hours of near work

The graph above is a representation of the correlation between individual and parental myopia. The exact prescription of an individual participant was compared with the severity of their parent's myopia, described using a five-point Likert scale, with 1 meaning mild myopia, 2 indicating moderate-mild, 3 being moderate, 4 indicating moderate-severe, and 5 meaning severe. The above graph (Figure 7) was produced from 120 responses and represents an r-value of 0.16 ($p = 0.62$).

Discussion

Demographics

The average eye prescription for males was -0.925 diopters (SD = 1.829), while females had an average of -0.821 diopters (SD = 1.635) (Table 1). However, these results were found to be insignificant after conducting a T-Test ($p = .37$). These results regarding gender align with those of Huang et al (2019), which state that, despite females having higher rates of myopia in the study, differences were noted to be insignificant after conducting a Chi-Square test.

Regarding ethnicity, those of Asian descent had an average prescription of -0.692 diopters (SD = 1.300), while African Americans had an average of -1.929 diopters (SD = 2.405), Hawaiian or Pacific Islanders had an average of -1.000 diopters (SD = 1.414) , Hispanic/Latino participants had an average of -1.091 diopters (SD = 2.587), and White participants had an average of -0.803 diopters (SD = 1.621) (Table 2). However, it is important to note that, after performing an ANOVA test, any variation found between races was not statistically significant ($p = .79$) and is most likely due to chance rather than underlying factors. Therefore, the results suggest that there is no significant difference in myopia based on race. However, these results do not align with those of Jones-Jordan et al., which state that those of Asian ethnicity generally have much higher rates of myopia compared to African American, Hispanic/Latino, and White individuals. Contrastingly, the results of this study indicate that any differences found between races was insignificant.

Environmental Factors

In terms of environmental influence, the following factors were assessed: time spent on electronic devices, time spent reading from books, and time spent outside performing a task that was not previously mentioned. By utilizing the information from Enthoven et al., which stated that the combined effect of all near-work activities can be counteracted proportionally by spending time performing far-work activities outside, the number of hours spent outside performing far-work activity was subtracted from the sum of hours spent on electronic devices and reading books. Pearson's correlation coefficient was then calculated using the number of hours spent on near-work along with the participants' matching eye prescriptions. For all calculations regarding significance, an alpha level of $p = .05$ was utilized. A weak correlation of some significance was found between time spent on near-work activity and eye prescription with $r(120) = .21$, and $p = .04$ (Table 4). This suggests that time spent performing near-work activities is related with an increase in myopia, but not to an extreme extent.

These results align almost perfectly with the findings of Wang et al. on smartphone overuse and myopia, which found that there was a weak, but statistically significant correlation between smartphone use and myopic development in children ages 12-19. Additionally, these findings support the results of the foundational source Huang et al., which, although sample a slightly older population, found that there is a significant association between myopia and continuous near-work activities (the exact activities specified included reading from mobile phones, computer screens, and physical books). However, the correlation found in this study between the two variables was weak, suggesting that the two factors are only loosely related. Overall, these results align with the literature, since myopia has been stated to be affected by more than just one factor, and the small but significant correlation between myopia and near-work activity demonstrates that while near-work activity may play a role in the development of myopia, it is not the sole determinant.

In terms of outdoor exposure, $r(120) = -.18$ means that the two are inversely related, so an increase in outdoor exposure led to a decrease in myopia (Table 5). However, a p-value of .37 means that, for the most part, these results are insignificant and thus no firm conclusions can be made. These results contrast with both Enthoven et al., as well as Huang et al., which both stated that there should be a significant inverse relationship between outdoor exposure and myopia. Contrastingly, the findings of this study suggest that there is no significant relationship between the two at all.

Biological Factors

In terms of biological factors, an approach based on Wang and Bi's analysis of the correlation between myopia and first-degree familial history of myopia was utilized. Firstly, it is important to note that, of the 39 myopic participants, 31, or 79%, had at least one other myopic individual in their family (Table 3). This means that myopia almost certainly is influenced by genetic patterns, since an overwhelming majority of myopes have, at the minimum, one other myopic family member. Additionally, participants provided the number of myopic individuals in their family, as well as the total number of individuals in their family. This was then turned into a fraction, with the number of myopic individuals being divided by the number of total individuals in the family. This fraction was then plugged into Pearson's correlation coefficient as an X value, and with corresponding participant eye prescription as a Y value, to determine the correlation between the two. Once again, for all calculations regarding significance, an alpha level of $p = .05$ was utilized. The two values had a moderately strong correlation of strong significance, with $r(120) = .65$, and $p < .01$ (Table 6). This suggests that an increase in the number of myopic family members increases the likelihood of myopia in an individual. This result aligns almost perfectly with the results of Huang et al., which found that there was a moderately strong correlation which was found to be significant. While the exact r-value differs between Huang et al. and this study, both are significant and fall into the "moderate" range. Similarly, Wang and Bi found that parental myopia was the strongest predictor of myopia in an individual, and that myopia is extremely heritable between siblings.

However, in addition to familial presence of myopia, the average myopic severity of the participant's parents, ranked on a 1-5 scale (1 being mild, 2 being moderate-mild, 3 being moderate, 4 being moderate-severe, and 5 being severe) was compared with participants' eye prescription using Pearson's correlation coefficient once again. However, the correlation between the two variables was weak and statistically insignificant, with $p(122) = .16$, and $p = .59$ (Table 7). This indicates that the severity of parental myopia has no effect on the severity of an individual's own myopia. Unlike the first result, these findings regarding individual and parental severity do not align with either foundational source. According to Wang and Bi there should be a weak but significant correlation between the severity of myopia in an individual versus their parents.

Qualitative and Interview Observations

Interviews confirmed most of the previous information, however they allowed the researcher to view the data from a qualitative perspective, as well as to be given specific information. The first participant had a prescription of -4.00D, and of all five members in their family, all five have had myopia during at least one point in their lives (it was stated that the participant's mother was myopic before she had undergone corrective laser surgery). However, the prescriptions of the participant's family members varied from the participant's own prescription; while the father had a similar prescription, the participant's brother had a prescription of -6.00D while the participant's sister had a prescription of only -1.00D. Regarding the second participant, results were similar. This participant had a prescription of -5.00D, and of the five members of the participant's family, four had some degree of myopia. However, similar to the previous interview, these values varied largely from the participant's own prescription. The participant's father only had a prescription of -1.50D, while the participant's mother was stated to have a prescription of -3.00D. While one of the participant's brothers was nonmyopic, the other brother suffered from severe myopia, with a prescription of -5.50D. Exact transcripts can be found in Appendix B.

Combined Influence

Looking at biological factors, the correlation between percent of family members being myopic and the participant's own myopia had a moderately positive correlation of strong significance, meaning that generally, the more members of one's family being myopic results in a higher severity of personal myopia. Additionally, the fact that out of the 39 myopic participants, around 79% having at least one myopic family member furthers the fact that myopia is more strongly correlated with biological factors rather than environmental factors. Comparing these results with environmental factors, it is clear that biological factors have a seemingly much larger influence on the development of myopia. These results directly contradict the expected results of similar/equal influences, since one factor clearly has stronger associations with myopia than the other. However, the complete lack of correlation between an individual's myopic severity and their parent's myopic severity suggests that, while the presence of myopia in one's family increases the likelihood for myopia in an individual, the severity of an individual's myopia is more of an acquired trait than a heritable one.

Conclusion

To restate, myopia is a form of refractive error that causes nearsightedness in an individual. It affects a large majority of the population and is one the primary needs for corrective lenses. Myopia has a multifactorial etiology, meaning that it is caused by a combination of multiple factors, which have been found to be genetic and environmental. Studies looking into the specifics of these factors, for example, Wang and Bi, find that the biological factors behind myopia mainly involve its heritability, meaning that it can be inherited from parents, tends to run in families, and is even influenced by race. Other studies, such as Enthoven et al., investigated the environmental factors of myopia and discovered two major findings. Firstly, performing near-work activities, for example reading from a computer, phone, or book, increased the progression of myopia, while time spent outside with exposure to the sunlight could have the opposite effect on myopia. However, one topic left unaddressed by these studies is which factor has the greater impact on myopia. This study aimed to determine whether biological or environmental factors have a greater influence on myopia, and it did so through its methodology, which looked at a population aged 14 to 18, within the time period of peak myopic development. A questionnaire was designed based on the works of foundational sources, and looked at myopia, as well as near-work and family history. Due to the methodology of foundational sources, a correlational method was utilized, comparing environmental factors with myopia and biological factors with myopia. The two main correlation values would be compared in order to determine which factor is more strongly correlated with myopia.

Major Findings and Implications

The lack of correlation between parental severity and individual severity detracts from the possibility of a clear, one-sided conclusion. However, the two major findings regarding the correlation between familial presence of myopia and individual myopia, as well as hours spent performing near work and individual myopia, were both statistically significant and strong enough to allow for a basic conclusion to be made. The findings of this study suggest that, in terms of the main constituents, biological factors have a larger impact on the development of myopia than environmental factors. This conclusion has many real-world implications. For example, knowing that myopia is largely determined by biological factors rather than environmental factors can allow for the better prediction of myopia in an individual. Previously, guesses of myopia in an individual could only be made based on how long they performed near-work activities, but these findings allow for the better prediction of myopia in an individual based on its history in their family. Additionally, a common intervention to the over-performance of near-work was to budget time spent on devices with electronic screens. However, if an individual's family has a history of perfect eyesight, such budgeting may be reduced, or entirely unnecessary.

Limitations

In terms of limitations, this study suffers from three major flaws. Firstly, a sample size of 122 was used in this study, however, both foundational sources Wang and Bi, and Huang et al. use a sample size of above 1000 to ascertain that results are representative of the larger population. A small sample size increases the variability of the results, which means that they could be unrepresentative of the population. Secondly, the population used in this study suffers from a lack of ethnic diversity, with less than 5 African American participants identified. This absence of ethnic diversity is most likely the cause of the lack of alignment with Jones-Jordan et al., since such a small number of African American and Hispanic responses leads to unrepresentative averages for those ethnicities, much larger variability, and thus, larger error bars. Lastly, one limitation of this study was the reliance on the participants of the questionnaire to estimate their own eye prescription. In Wang and Bi, an auto refractometer was used to perfectly determine the level of myopia in an individual, but as such a tool was unavailable for use in this study, and thus the study relied on the participant's own knowledge of their eyesight. This may have resulted in potentially inaccurate results, since it is possible that students were unaware of their own prescription and made inaccurate or outdated guesses.

Future Research

Future research on the topic could be aimed at treatment and preventative measures for myopic progression. Currently, the majority of research on the topic is aimed at clarifying the causes behind myopia, but these findings can be utilized in future research on how to prevent myopia based on its causes. Since the results of this study suggest that biological factors have a larger impact on the development of myopia, future research on preventative measures could be aimed more specifically on genetics, since if the trait could be eliminated from one generation, it would potentially be eliminated from all future generations.

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