ASSOCIATION BETWEEN MYOPIA AND AMPLITUDE OF ACCOMMODATION IN YOUNG ADULTS

by

DR. NG SOK LIN

MD (USM)

Dissertation Submitted In Partial Fulfillment Of The Requirements For The Degree Of Master Of Medicine (Ophthalmology)

UNIVERSITI SAINS MALAYSIA

2001

ACKNOWLEDGEMENT

My sincere thanks and deepest appreciation to my supervisor, Dr. Elias Hussein, lecturer of Department of Ophthalmology, Hospital Universiti Sains Malaysia, for his guidance and support throughout the planning and duration of this study and for his invaluable advice and constructive criticism during the preparation of this dissertation.

I wish to express my greatest appreciation to Dr Mohtar Ibrahim, Head Department of Ophthalmology, and all the lecturers in the Department of Ophthalmology, Hospital Universiti Sains Malaysia (HUSM). Thank for their outstanding teaching, guidance and encouragement throughout my course. My warmest appreciation to all my fellow colleagues for their friendship, cooperation, assistance and encouragement.

A special thanks goes to our statistician, Dr. Syed Hatim and my colleagues from Department of Community Medicine, HUSM, Dr. Maizun Binti Mohd Zain, Dr. Wan Mohamad Zahirnuddin Bin Wan Mohamad, Dr. Suhaiza Binti Sulaiman and Dr. Nor Sa'adah Binti Bachok, for their endless assistance in statistics.

My thanks to Encik Amir for his excellent photography.

My warmest appreciation to my husband, Dr. Yew Cheng Hoe, my children, Wei Chee and Wei Ni and my parents, without whose support and encouragement I could never complete this course.

TABLE OF CONTENTS

LIST OF TABLES.

LIST OF FIGURES.

ABSTRAK.

Objektif: Tujuan penyelidikan ini adalah untuk mengkaji hubungan diantara amplitud akomodasi (amplitude of accommodation) dan masalah refraksi (refractive error) di kalangan penuntut-penuntut perubatan dan kejururawatan daripada Pusat Pengajian Sains Perubatan (PPSP), Universiti Sains Malaysia. Disamping itu, faktor-faktor lain yang berkaitan dengan rabun jauh (myopia) turut disiasat.

Tatacara: Sejumlah 110 penuntut-penuntut perubatan dan kejururawatan daripada PPSP Universiti Sains Malaysia, Kubang Kerian, Kelantan terlibat dalam penyelidikan ini. Sample dipilih daripada populasi dengan kaedah 'stratified random sampling' (stratified random sampling method). Masalah rabun masing-masing ditentukan, jarak 'near point' (near point distance) dan jarak 'far point" (far point distance) diukur pada kedua-dua mata pada masa yang berasingan. Amplitud akomodasi dikira secara penolakan 'far point'(unit diopter) daripada 'near point' (unit diopter). Data analisis dilakukan dengan program SPSS.

Keputusan: Rabun jauh (ditakrifkan sebagai mereka yang mempunyai masalah refraksi sebanyak –0.75 diopter dan keatas) mempunyai amplitud akomodasi yang rendah (p=0.012). Faktor-faktor lain yang berkaitan dengan masalah rabun jauh termasuk faktor keturunan (p=0.002) dan faktor etnik (ethnic) (p=0.021). Penuntut-penuntut yang mempunyai latarbelakang keluarga yang berabun jauh merupakan kumpulan yang lebih berisiko ('odds ratio' 4.4, p=0.002). Analisis pelbagai logistik regrasi (multivariate logistic regression analysis) menunjukkan bahawa amplitud akomodasi yang rendah (p=0.009) serta faktor keturunan (p=0.002) mempunyai huhungan rapat dengan rabun jauh. Mereka yang mengidap rabun jauh pada peringkat umur muda (early onset myopia) berisiko tinggi untuk mendapat rabun jauh yang teruk (p=0.005). Dari analisis pelbagai logistik regrasi, rabun jauh pada peringkat umur muda didapati mempunyai risiko sebanyak lima perpuluhan satu kali ganda menjadi rabun jauh yang teruk ('odds ratio'= 5.1, p=0.005).

Kesimpulan: Penyelidikan ini mendapati amplitud akomodasi yang rendah dan faktor keturunan merupakan faktor-faktor penting berkaitan dengan rabun jauh. Disamping itu, rabun jauh pada peringkat umur muda didapati berisiko tinggi untuk menjadi rabun jauh yang lebih teruk.

ABSTRACT.

Objectives: To describe the association between amplitude of accommodation and refractive error as well as to evaluate the risk factors associated with myopia among medical and nursing students from School of Medical Sciences, Universiti Sains Malaysia.

Methods: A total of 110 medical and nursing students with both eyes classified into the same refractive state namely emmetropia, low myopia and moderate to high myopia were enrolled in this study. The sample was randomly selected from the population with the stratified random sampling method. Refractive error, near point distance and far point distance were measured. Each eye of each subject was tested separately. The amplitude of accommodation was calculated by subtracting the far point (in diopters) from the near point (in diopter). Data analyzes was performed using SPSS software.

Results: Myopes were defined as those with refractive error of −0.75 diopter or more, have lower accommodative amplitudes (p=0.012). Family history of myopia (p=0.002) and race (p=0.021) were other risk factors associated with myopia. Those with family history of myopia are at higher risk of getting myopia (odds ratio 4.4, p=0.002). After multivariate logistic regression analysis adjusting for various relevant variables, lower amplitude of accommodation (p=0.009) and family history of myopia (p=0.002) remained associated with myopia. Myopes with early onset myopia were related to higher degree of myopia (p=0.005). Early onset myopic subjects are at 5.1 times greater risk of getting higher degree of myopia (odds ratio = 5.1, p=0.005).

Conclusions: This study demonstrates that lower amplitude of accommodation along with family history of myopia is important risk factors associated with myopia. On the other hand, the early onset of myopia is the risk factor for higher degree of myopia.

1. INTRODUCTION

1. INTRODUCTION

Myopia, or nearsightedness, has been undergoing a major re-evaluation in recent years both by ophthalmologists and basic scientists, though for different reasons. For ophthalmologists the rise of refractive surgery in the past decade has seen myopia changing from a condition requiring optical correction to one that can be managed surgically with the aid of the excimer laser and other techniques. For basic scientists interested in the control of eye growth, the past decade has been equally revolutionary with a huge increase in the understanding of mechanism by which eye growth is regulated by the quality of the retinal image. This research offers insights into why myopia develops in humans and offers clinicians a novel perspective from which to approach the management of myopia. Rather than attempting to alter corneal curvature to "treat" myopia, it may be possible to prevent or "cure' myopia by directly manipulating the growth mechanisms of the eye.

Myopia is defined clinically as a mismatch between the power of the optical elements of the eye and the axial length that causes images to focus in front of the retina and results in blurry images on the retina. The corrective lenses or other refractive treatment is required to produce a clear image (Wensor et al., 1999; Zadnik et al., 1994).

The public health and economic impact of myopia, the most common eye condition in the world, is enormous. In the United States, the cost of correcting refractive errors with spectacles or contact lenses is estimated to be 2 million dollars per year (Saw et al., 1996).

Many investigations have been carried out during the last 150 years to detect factors, which cause myopia. In the ophthalmic literature, there has been extensive discussion whether myopia is caused by hereditary or environmental factors. The causes of myopia are unclear, although evidence supports both genetic and environmental components. Hereditary factors are implicated in myopia and one widely accepted explanation for the role of education and intelligence is that the accommodation involved in near work, particularly reading, can provoke elongation of the eyeball in genetically susceptible individuals (Teasdale et al., 1988). Interest has been focused on accommodation because of the established association between myopia and the amount of close work, or working at a close distance, years of education and intelligence. It remains unclear, however, to what extent greater levels of education and intelligence are associated with a greater degree of myopia.

The earliest suggestion of a link between accommodation and myopia appears to be that of Kepler (1611). Whilst numerous subsequent authors have also suggested that the development of myopia is related to the action of accommodation (Stansbury, 1948; Goldschmidt, 1968; Duke-Elder and Abrams, 1970; Curtin, 1970, 1985), to date no clear mechanism has been elucidated.

The Early Treatment Diabetic Retinopathy Study, a randomized clinical trial, was designed to study the timing of photocoagulation and aspirin therapy for diabetic retinopathy. A test of accommodation was performed at baseline in patients who were younger than 46 years and had best-corrected visual acuity of 20/40 or better (Braun et al., 1995). The study shows that eyes with myopia have lower accommodative amplitude. Eyes with lower amplitudes of accommodation must use more of their accommodative reserve for near work. So myopia may be an adaptation that develops in eyes with reduced accommodative amplitudes to reduce the demands of near work.

One limitation of this study is that the study population was composed entirely of persons with diabetic retinopathy and lower amplitudes of accommodation (Fong, 1997). Another study demonstrated that diabetes and duration of diabetes, along with age, were important risk factors for reduced accommodative amplitude (Braun et al., 1995). This fact has initiated an idea of performing a study to find out the association between amplitudes of accommodation and refractive error in the normal healthy individual. The aim of the study was to find out whether low amplitude of accommodation also occurs among the normal healthy myopic individual.

It is unclear at the present time whether myopia develops as a result of an abnormal accommodative response, or alternatively that the accommodative stimulus is reduced as a consequence of myopic development. Prospective studies measuring accommodative amplitudes at baseline and monitoring the development of refractive error are needed to determine whether lower amplitudes of accommodation lead to myopia.

The amplitude of accommodation reflects the maximum accommodative response, and has been defined as the dioptric distance between the far point (point conjugate with the retina when accommodation is fully relaxed) and the near-point (point conjugate with the retina when accommodation is fully exerted) of accommodation (Rosenfield, 1997). A number of studies have reported significant variations in this parameter with refractive error. Maddock et al. (1981) and McBrien and Millodot (1986a) subdivided their myopic population into either low (<3D) and high (>3 D) myopes, or early- (myopia onset at 13 years of age or earlier) and late- (myopia onset at 15 years of age or later) onset myopes. Since the late-onset myopes are also typically low myopes, both studies reported similar findings, with low myopes having higher amplitudes than high myopes. However, both myopic subgroups had higher amplitudes than either emmetropes or hyperopes. In contrast, Fisher et al. (1987) did not observe any significant variation in the nearpoint of accommodation with refractive error.

Myopia has become a problem of public health concern in the world. The prevalence of myopia in Singapore is one of the highest worldwide. It is interesting to conduct study on myopic population in Malaysia to find out whether myopia is also a problem of public health concern in our country. However the nationwide myopic research was impossible for me at this stage due to limitation of time and lack of manpower. In order to conduct a myopic research within a short period of time and alone, the medical and nursing students from School of Medical Sciences, Universiti Sains Malaysia (USM) were selected as my study population. The primary objective of the study was to elicit the association between amplitude of accommodation and myopia among healthy normal medical and nursing students in USM. The aim of the study was to find out whether low amplitude of accommodation also occurs among the normal healthy young myopic individual beside diabetic patients discussed earlier. The second objective was to find out the possible risk factors associated with myopia and degree of myopia among medical and nursing students in USM.

The study was set out to answer three questions:

1. Is there any association between myopia and amplitude of accommodation in the medical and nursing students in USM?
2. Does degree of myopia affects the amplitude of accommodation?
3. What are the risk factors for myopia and degree of myopia among medical and nursing students in USM?

THE NULL HYPOTHESIS (Ho).

1. There was no association between amplitude of accommodation and myopia in the medical and nursing students in USM.
2. There was no association between amplitude of accommodation and degree of myopia.
3. There was no sosiodemographic factors (example: sex, race, family history of myopia, place of residence) affecting myopia among the medical and nursing students in USM.

In the future, we may try to establish whether low amplitude of accommodation is the cause for myopia or the other way round by conducting a prospective study measuring accommodative amplitude at baseline and follow up to monitor the development of refractive error.

1.1 OBJECTIVES

1.1. OBJECTIVES

1.1.1 GENERAL OBJECTIVE

To describe the association between amplitude of accommodation and refractive error among medical and nursing students from School of Medical Sciences, Universiti Sains Malaysia.

1.1.2 SPECIFIC OBJECTIVES

i. To measure the amplitude of accommodation in myopic and emmetropic individuals.

ii. To compare the amplitude of accommodation in relation to the refractive status and degree of myopia.

iii. To evaluate the risk factors for myopia and degree of myopia.

2. LITERATURE REVIEW

2. LITERATURE REVIEW.

Myopia is the state of refractive error in which parallel rays of light come to a focus in front of the sentient layer of the retina when the eye is at rest (Duke-Elder and Abrams, 1970). Helmholtz defined myopia in terms of the position of the far point plane (objects situated in this plane are focused on the retina), this being in front of the eye in myopia, and pointed out that light entering the eye had to be divergent in order to be focused on the retina of the myopic eye.

Myopia is measured by the spherical power in diopters of the diverging lens needed to focus light onto the retina, which can be expressed as the spherical equivalent or refraction in the least myopic meridian (Saw et al., 1996). The clinical correlates of myopia include blurred distance vision, eye rubbing, and squinting.

During the past several years an increasing amount of data has become available concerning the prevalence of myopia at various stages of life, particularly during the early years. The prevalence of myopia is approximately 20% in the United States population. This frequently varies with age, sex, race, ethnicity, occupation, environment, and other factors in various sampled populations (Curtin & Whitmore, 1995).

Many studies show that by the age of 5 or 6 years, only about 2 percent of children have myopia of 0.50 D or more (Kemph et al., 1928; Blum et al., 1959; Hirsch, 1964; Laatikainen and Erkkila, 1980; Mantyjarvi, 1983). It is known that many children who are emmetropic when entering school become myopic during the school years. The prevalence of myopia of 0.50 D or more increases in a relatively linear manner from about 2 percent at age 6 to about 20 percent at age 20. Between the ages of 20 and 40 years, the prevalence of myopia reaches a peak of about 30 percent. After which it begins to decrease because of the tendency for some of the low myopes to lose their myopia, rejoining the emmetropic group. But the prevalence of myopia (of 0.50 D or more) increases somewhat in the later years of life due to the presence of nuclear lens changes, as suggested by Hirsch (1958).

The prevalence of refractive anomalies varies widely from one geographical, racial, or occupational group to another. Baldwin (1967) has reviewed much of the literature concerning the prevalence of myopia in various racial and occupational groups. One of the most interesting studies cited by Baldwin was that of Crawford and Hammar (1949), who screened 50,000 school children of various racial groups living in Hawaii. They found that the percentage of children having myopia ranged from about 3 percent for Hawaiian children to 12 percent for Caucasian children and 17 percent for Chinese children.

Even within a single racial or ethnic group, the prevalence of myopia has been found to vary greatly with occupation. Baldwin (1967) reviewed the results of six studies in which the prevalence of myopia was compared for near workers and those not engaged in near work. The mean prevalence of myopia for near workers was approximately 33 percent as compared to 15 percent for non-near workers.

In Malaysia, the National Eye Survey was carried out between 1996 and 1997 with the primary objective to provide accurate and statistically representative information regarding the actual visual status and the prevalence of eye diseases in the Malaysia population. Prevalence of visual impairment due to refractive error in Malaysia was reported based on sex, ethnicity, age group, urban-rural residence and state (Table 2.1). The overall prevalence of visual impairment due to refractive error in Malaysia was 1.18% (Mohamad et. al., 1996).

Table 2.1. Prevalence of visual impairment due to refractive error based on sex, ethnicity, age group, urban-rural residence and state in Malaysia.

		Prevalence (%)
Overall		1.18
Sex		
	Men	0.89
	Women	1.48
Race		
	Malay	1.20
	Chinese	0.90
	Indian	1.27
	Others	1.74
Age group		
	0-9	0.31
	10-19	1.38
	20-29	1.24
	30-39	0.63
	40-49	1.71
	50-59	2.78
	60-69	2.90
	>= 70	2.46
Urban or rural residence		
	Urban	1.24
	Rural	1.13
State		
	Johore	1.69
	Kedah	1.14
	Kelantan	0.60
	Melaka	1.34
	Negeri Sembilan	0.26
	Pahang	0.42
	Penang	1.15
	Perak	1.60

Table 2.1, continued.

Perlis	1.37
Sabah	2.18
Sarawak	0.79
Selangor	0.55
Terengganu	0.97
Kuala Lumpur	2.15

Since the time of Donders, many systems for the classification of myopia have been proposed, many of which have been based on observed or assumed etiological factors. Donders (1864), who believed that myopia occurred as a result of prolonged use of the eyes for close work, classified myopia into three categories on the basis or rate of progression:

1. *Stationary myopia*, usually of low degree, not progressing throughout the life spans.
2. *Temporarily progressive myopia*, progressing only during the early years of life.
3. *Permanently progressive myopia*, of high degree by the age of 15 years and continuing to progress throughout life.

Duke-Elder (1949) has classified myopia into just two categories:

1. *Simple myopia*, occurring as a result of normal biological variability, making its appearance between age 5 and puberty, with its progression tending to stabilize after adolescence.
2. *Degenerative myopia*, the degenerative changes occurring particularly in the posterior segment of the globe – is relatively rare, but frequently leads to visual disability and not infrequently to blindness.

It is a widespread practice to distinguish two forms of myopia, a rare pathological form and a less severe simple form. The pathological form can show several complications, including chorioretinal degeneration, and it almost always appears in association with a high refractive error, usually to some degree above –8.0 diopter (D). The much more common myopia of degrees below –8.0 D are almost always of the less severe form. It is sometimes called "school myopia", because it typically develops in children of school age and because epidemiological studies have persistently shown it to be associated with high educational attainment (Teasdale et al., 1988).

A simple classification of myopia, though not a particularly informative one, is by degree. Hine (1949) classified myopia of less than 3 D as low, of 3 D to 6 D as moderate, and of more than 6 D as high. Hirschberg proposed a classification similar to Hine's except with the additional category of very high myopia for refractive errors greater than 15 D. Severe myopia may be associated with myopic macular degeneration, cataract, glaucoma, peripheral retinal changes (such as lattice degeneration), and retinal holes and tears, as well as retinal detachment.

As a result of an epidemiological study of myopia in Denmark, Goldschmidt (1968) proposed the existence of three types of myopia, classified on the basis of both the degree of myopia and the age of onset:

1. *Low myopia,* the most frequent type of myopia, principally genetically determined, developing during the first 20 years of life, progressing steadily and rarely exceeding 6.00 to 9.00 D.

2. *Late myopia*, developing after the cessation of bodily growth, seldom reaching higher degrees, and seemingly related to excessive close work.
3. *High myopia*, either genetically or environmentally determined, frequently having an early onset and capable of reaching excessive degrees, causing severely reduced vision and degenerative changes in the eye over a period of years.

Defining myopia as "expansion glaucoma," brought about by an increase in intraocular pressure, Kelly (1981) described three types of myopia, classified on the basis of etiology:

1. *Self-inflicted vitreous glaucoma* (simple myopia) due to blockage at the zonular level, accounting for 90 percent of myopia, occurring because the ciliary body, during accommodation, pulls forward on the thick anterior vitreous, concentrating the zonule and closing the zonular gap.
2. *Active anterior chamber glaucoma* (malignant glaucoma) due to the presence of a retinoschisis like membrane blocking the trabecular area, accounting for 5 percent of myopia.
3. *Inactive glaucoma* (congenital glaucoma) due to an intraocular pressure rises in utero.

In The Myopia, Basic Sciences and Clinical Management, Curtin (1985) introduced a system of classification based on etiology, degree of myopia, and time of onset:

1. *Physiologic myopia* (simple or refractive myopia), developing postnatally because of a correlation failure between the total refracting power of the eye and a normal axial length.

2. *Intermediate myopia* (axial myopia), medium or moderate myopia, due to an expansion of the posterior segment of the globe in excess of normal ocular growth, subdivided into congenital, childhood, and late myopia.
3. *Pathologic myopia,* a special form of axial myopia, defined as the ocular disease in which a number of serious complications are associated with abnormal lengthening of the eyeball. It is often associated with thinning of the scleral wall and posterior staphyloma. .

Grosvenor (1987) has proposed a myopia classification base on the basis of age of onset. Grosvenor's classification system includes four categories:

1. *Congenital myopia.* Myopia is present at birth and persists through infancy, with high myopia being the general rule.
2. *Youth*-onset myopia/ school myopia. Becomes manifest during the early childhood from about age 6 years through the teenage years and stabilizes by the late teens or early twenties.
3. *Early adult-onset myopia.* This form of myopia has its onset during the period from age 20 to about age 40. Many of those will have only a small amount of myopia and will become emmetropic or even hyperopic in their later years.
4. *Late adult-onset myopia.* This form of myopia has its onset beyond the age of 40.

Both school and adult- onset myopia are mainly the result of idiopathic causes, while congenital myopia is often associated with other abnormalities.

Unlike hyperopia or astigmatism, once myopia is found to exist, it tends to progress. For example, data from Hirsch's (1964) longitudinal study of refraction between the ages of 5 to 6 and 13 to 14 years indicated that hyperopia tends to decrease by a small fraction of 1.00 D per year. Myopia occurring during the adult years, on the other hand, tends to progress at a slower rate. In most cases the myopia tended to increase in a linear manner into the middle or late teen years, then level off.

Both the Goss and Winkler (1983) data and the Grosvenor et al. (1987) data tend to confirm the observation that the earlier a child becomes myopic, the more rapidly the condition tends to progress. Consequently, a child who becomes myopic at an early age (by age 6 or 7) will not only have more years to progress prior to cessation (at age 15 or 16 ± 2 years) but will be likely to progress at a significantly faster rate than if the myopia had presented itself at a later age. Myopia tends to progress slowly in the adult years. Myopic progression is connected with much use of the eyes in reading and close work and with short reading distance (Parssinen et al., 1989).

Different studies have adopted different definitions of myopia. The most common definitions are a refractive error greater than 0.25 diopter and a refractive error greater than 0.50 diopter. The lack of uniform criteria has led to difficulties in comparing prevalence rates in different studies. All studies should specify the definition of myopia used and the range of refractive error of the subjects in the study.

Both environmental and genetic factors have been associated with the onset and progression of myopia. The use-abuse theory states that close up work causes myopia, as seen in the higher prevalence of myopia among persons who are more highly educated and are in white collar occupations. The mechanisms underlying the environmental and genetic factors, and the nature of the interaction between the two factors is not certain. Educational level, intelligence, certain personality traits, and socioeconomic status have all been associated with myopia (Saw et al., 1996). Premature and low birth weight infants have a higher risk of developing myopia later in life (Quinn et al., 1992).

Family studies by Sorsby et al. and Keller demonstrated significant parent-child correlations. There is a greater prevalence of myopia in children of myopic parents than in children of nonmyopic parents. It is unknown, however, to what extent these familial patterns are due to genetic or environmental factors. Zadnik et al found that children with two myopic parents have longer eyes than do children with nonmyopic parents, even though the children were still hyperopic at the time of measurement. However, these children were less hyperopic than the children with nonmyopic parents. There is evidence that the ocular components and refractive errors of monozygotic twins are more closely aligned than they are for dizygotic twins, suggesting a genetic component (Zadnik et al., 1994). The role of heredity is postulated to be more significant in persons with higher degrees of myopia.

The exact mode of inheritance and possible genetic markers for myopia have not been identified. Not all observations, such as the increase in myopia prevalence in Taiwan, Singapore, and Hong Kong, can be explained solely by genetic causes. There may be an interaction between genetic and environmental factors wherein some individuals have a genetic predisposition such that they are more susceptible to environmental influences causing myopia.

Acquired myopia, on the other hand, is a much greater problem because almost one-third of the population in an industrialized society (and as many as two-thirds in some population groups) will become myopic after several years of schooling or during the adult years. A large amount of attention has been given to discovering the cause of acquired myopia. In On the Anomalies of Accommodation and Refraction of the Eye (1864), Donders proposed that myopia occurs as a result of prolonged tension on the eyes during close work and elongation of the visual axes.

Near work has been linked to myopia for more than a century (Ware, 1813; Cobn, 1886; Angle and Wissmann, 1980; Richler and Bear, 1980; Rosner and Belkin, 1987). Many subsequent studies have demonstrated that higher prevalence of myopia are associated with tasks involving significant amounts of near work require high accommodative demand, such as reading, writing, computer work, and close television viewing. The incidence of myopia increases at the time children start attending school, and this suggests that closeup work may be a cause of the development of myopia. An increased prevalence of myopia is observed in certain occupations, such as microscopy, sewing, and carpet weaving that require a large amount of time spent in closeup work. Further evidence for the close-work hypothesis is the higher prevalence of myopia among college graduates, with a higher number of new cases in the college years, compared with other adults in the same age group. Although much has been made of the potential causative role for accommodation in the development of myopia, studies of myopia and near work all report associations, not necessarily causation. There are associations of near work with both the prevalence and degree of myopia. Many factors appear to influence these associations, including geographic considerations, occupation, age, gender, education, intelligence and degree urbanization of place of residence (Au Eong et al., 1993).

Teasdale et al. (1988) observed that the prevalence of myopia increased with intelligence test score. However, increasing intelligence did not correlate with the degree of refractive error for myopia greater than 2.0 D. They concluded factors associated with intelligence and education seem to be important in triggering the onset of myopia, they seem to be much less important in determining the degree to which myopia progresses. (Teasdale et al., 1988).

The dramatic increase in computer utilization in recent years, both in the workplace and domestic environment, has led many practitioners to suggest that video display terminal (VDT) use may be associated with the development or progression of myopia. However, a review of the literature by Mutti and Zadnik (1996) noted a high prevalence of asthenopia amongst computer users but no clear evidence of any association with myopia progression (Mutti and Zadnik, 1996).

Myopia was found to be significantly higher in people with higher education levels, in clerks and professionals (Paritsis et al., 1983; Wensor et al., 1999). The higher prevalence of myopia associated with increased educational demands also suggests that near work produces myopia.

A number of studies have reported markedly lower prevalence of myopia among more rural populations (Garner et al., 1988, 1990). These studies have been cited as evidence of the environmental etiology of myopia. Lithander (1999) reported significant less myopia in remote areas and high myopia was seen in one of Oman's major cities.

Accommodation is probably present from birth, but is initially inaccurate and principally operative over a short range until the age of about 3 months. It is thought that the main constraints on accommodative function in infants are attention and detection of the blur signal. There is considerable evidence suggesting that, under ideal conditions of attention, infants' accommodation is good enough to give them the acuity that their sensory system can resolve (Evans, 1997).

The amplitude of accommodation is a measure of the closest point at which the eyes can focus; it is the range from the far point to the near point in dioptres. Because it is measured from the far point, the measurement needs to be taken with the distance correction in place. It is therefore assessed after the refractive part of the routine examination (Evans, 1997). The amplitude of accommodation decreases with age.

Accommodation can be stimulated either by moving a test object closer to the eyes or by placing minus lenses in front of the eyes. Either of these procedures can be used to determine the amplitude of accommodation. The first method called the push-up or Donders method. The second method is called the minus lens method.

Mathematically, the amplitude of accommodation can be calculated from the reciprocals of the near and far point distances measured in meter. These are the dioptric values of the near and far point distances. The amplitude of accommodation is given by the formula

$$\mathbf{A} = \mathbf{P} - \mathbf{R}$$

Where **A** is the amplitudes of accommodation in diopters.

P is the dioptric value of the near point distance.

R is the dioptric value of the far point distance.

The amplitude of accommodation declines with advancing age, giving rise to the condition of presbyopia — the inability to focus near objects. This is due mainly to sclerosis of the fibers of the crystalline lens and changes in its capsule, which reduce the spontaneous steepening of its surfaces when the ciliary muscle contracts. Also it may be that the ciliary muscle itself becomes less efficient with advancing age (after 40 years old).

TABLE 2.2. Donder's Table showing Amplitude of Accommodation as related to age (Borish, 1970).

Age (years)	Amplitude (Diopter)	Age (years)	Amplitude (Diopter)
10	14.00D	45	3.50D
15	12.00	50	2.50
20	10.00	55	1.75
25	8.50	60	1.00
30	7.00	65	0.50
35	5.50	70	0.25
40	4.50	75	0.00