# A HEALTH PSYCHOLOGY-BASED RATIONALE FOR THE PREVENTION OF MYOPIA

## The Autonomous University of Madrid (AUM) Model of the Genesis and Development of Myopia

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**Abstract**

*The purpose of this paper is to present a model of the genesis, continuance and increase of myopia from the health psychology standpoint. This model makes it possible to pinpoint the characteristics of the population at risk and the resulting preventive action. Lastly, two parallel lines of research are proposed, the first aimed at the ongoing epidemiological study of a risk population and a non-risk population in accordance with the model, enabling transverse and longitudinal studies. The second seeks to study the effectiveness of the preventive actions, initiating the process with individual preventive intervention and later testing with community-wide preventive intervention.*

**Key Words**

*myopia, genesis model, prevention, health psychology*

Myopia represents one of the most outstanding public health problems in the Western countries. Epidemiological studies in different countries reveal that: (a) prevalence of myopia has increased in the last several decades;[1-3] (b) there are large differences across countries[4] (c) that beyond biological variables (ocular structure), sociological variables (occupation, educative and economic levels),[5] environmental variables (urban residence, lighting),[6] and psychological variables (lifestyle, reading behavior)[7] play an important role in myopia's etiology. Health psychology proposes that the genesis of myopia is related to individual lifestyle, ecosystem demands where the person lives and the ocular system's capacity to cope with such demands. This paper proposes a model of the genesis of myopia and research strategies for preventive intervention.

### The Autonomous University of Madrid (AUM) Model

There are two basic questions which a theory of myopia must answer. The first is how an individual who is slightly hypermetropic or emmetropic in childhood (up to age 10 or 12) later becomes progressively myopic and must be corrected. The second is why other individuals living under the same conditions do not develop myopia.

The genetic predisposition factors that indicate a greater propensity toward myopia have not yet been discovered. The current levels of precision in ocular biometry do not yet provide the means to determine the predictive morphological variables. Furthermore, predictive environmental variables seem to be related to close visual work and what is generally called *eyestrain*.

Our model represents a radical change in theoretical positions from earlier work,[8,9] but it also displays continuity in our mode of analysis. In fact, no especially new data have been unearthed in our research on the subject; rather, a need to develop a model of the genesis of myopia in order to continue with our research programs in the area of health psychology has led to this change.

The aim of health psychology is to study the individual's behavior in relation to health in a broad sense,[10] particularly behaviors enabling a person to remain healthy.[11,12] Health psychology states that the setting or ecosystem where the individual lives is as important as his or her health-related behavior. It is stated, in fact, that behavior is healthy when it proves adaptive in the short and long term. From this standpoint, preventive intervention on a particular disorder would involve changing individual behavior and the ecosystem where the individual lives to ensure the best possible adaptation and prevent the subject from falling ill. Health psychology develops etiological models of illness and health and intervenes preventively.

Until now our group did not accept the structuralist theories of the genesis of myopia, due mainly to the therapeutic progress we had achieved using a functionalist framework.[13-16] However, with the model presented here, the classification of myopias into functional and structural no longer has any point, since in this model they are interrelated. As will be seen, with this model we may speak only of *myopias*

*of functional etiology and myopias of pathological etiology.*

Our model is based on the following premises:

The first is that the behavior of the human individual and each of his or her subsystems allows the individual to adapt to his or her ecosystem. Thus the level of visual adaptation of an individual is determined by the resolution (degree of visual acuity) demands of the surroundings in which that individual lives. Currently these demands include resolution at both short (30 centimeters) and long (over 5 meters) distances, though the demands of the *modus vivendi* mean that a large part of the individual's time is dedicated to close work.

The second basic premise of our model is that when an individual has difficulty in visual resolution the ocular system develops various compensatory mechanisms which in many cases result in myopia.

The third basis is that the adaptation of the ocular system to a short distance viewing environment produces myopia due to difficulties in relaxing the ciliary muscle and the subsequent elongation of the eye's axis.[17-19]

Thus, on these premises, the AUM Model (Figure 1) seeks to explain the conditions allowing the onset of what might be called *incipient myopias* or *pre-myopias*. As shown in Figure 1, there are two factors determining the elongation of the eyes' axial length and the resulting myopia: (a) factors relative to the variables of the ocular system which imply difficulties in resolution (shown on the left of Figure 1) and (b) ecosystem variables (light, distance, etc.) shown on the right in Figure 1.

According to the model, in general, the population at risk for myopia refers to schoolgoers in their teens, of high labile growth, living in cities with high visual demands for near and distant resolution.

The left hand column in Figure 1 shows the conditions of the ocular system with intrinsic risk of myopia. Evaluation of these variables in the teenage school population not already diagnosed as myopic reveals those students who, while not myopic, are very likely to become so in the future. The right hand column shows what we consider to be the risk conditions of the ecosystem and behavioral styles (reading, computer work, remaining in small spaces

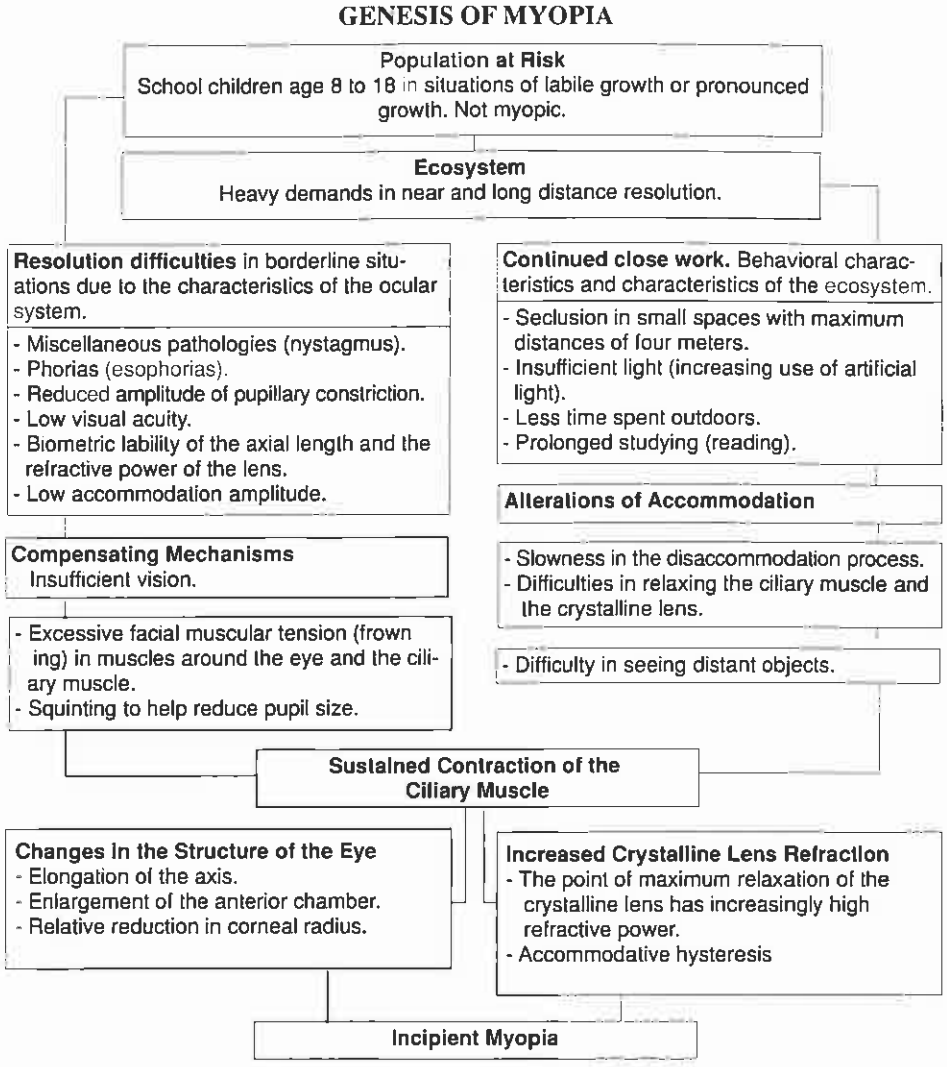


*Figure 1. The AUM Model of the Genesis of Myopia.*

with insufficient light, etc. over long periods and without rest intervals).

According to the model, insufficient vision in both near and distant situations provokes compensatory mechanisms in the ocular system aimed at enhancing resolution, leading to sustained ciliary muscle contraction. On the other hand, the features of the ecosystem also lead to greater ciliary muscle contraction, as indicated in the epidemiological work,[20,21] and experimental studies on animals.[17,22] These and other studies indicate that activities related to close visual work are associated with myopia. Therefore, both the ocular system insufficiencies and the features of the ecosystem equally induce *sustained ciliary muscle contraction.*

As we see it, this sustained contraction of the ciliary muscle caused in the two ways indicated above, mostly due to close work but also to general difficulties in resolution,[23,24] is responsible for (a) reduced speed of accommodation, (b) reduction of accommodative amplitude and, finally, (c) *elongation of the axis of the eye* through the transformation of the ocular globe into an ellipsoidal body with its focal points along the axis. Van Alphen[25] describes how the parasympathetic and sympathetic activation (or inhibition) of the ciliary muscle allows for greater tension in the muscle, which is responsible for stretching the sclera and increasing the depth of the anterior chamber.

The elongation of the eye's axial length is the variable which, along with the lens's inability to relax, explains most of the variance in the *refractive error of myopic individuals* in their initial phases. Consideration is now given to seeing how and why the axis becomes elongated. Simply following the laws of physics, we might assume that the *sustained contrac-*

*tion of the ciliary muscle* produces a reduction of the circle in whose plane it lies so that it pulls the sclera toward the center of the eye and increases intraocular pressure in the anterior chamber, forcing the chamber to become elongated.[17,22] Consequently, the ocular globe is transformed into that ellipsoidal, football-shaped body. Secondly, we might say that the *eye adapts to the excessive tension of the ciliary muscle by stretching the antero-posterior axis.* In this case we are assuming that the general tendency of the ciliary muscle is to relax, but the demands of the ecosystem (close work) prevent this relaxation. Thus, the only way to see (to focus on near objects) while maintaining relative relaxation of the ciliary muscle is to elongate the axis. In this manner the *ocular globe adapts to the ecosystem and avoids excessive muscular tension in the ciliary, creating a new problem which surfaces immediately as the inability to resolve distant objects.* Changes in the ocular globe's length and refractive power of the crystalline lens cause incipient myopia, according to the AUM model.

The pioneering work of Skeffington in the '50s must be acknowledged concerning the adaptation hypothesis, as must the work of Birnbaum,[26,27] suggesting that myopia is a process of adaptation to close work and that " ... myopia reduces the accommodation required to maintain clarity at near, and hence reduces associated overconvergence." According to Skeffington,[28] it is possible that adaptation to nearpoint stress may lead to conditions other than myopia, such as impaired binocular vision and information processing capacity, or avoiding close work.

## Preventive Action and Progression of Myopia

This model offers certain advantages in that *it pinpoints the characteristics of the population at risk* and tells us how to design *preventive action* against myopia. According to the model, the risk population consists of individuals with certain ocular characteristics and specific variables, some of which are indicated in Figure 1. They may, however, be summarized as all those variables which finally result in reduced visual acuity no matter what the working conditions (lighting or distance). There are detailed studies of each of these variables: Avetisov,[29] Rosenfield and Gilmartin,[30] and Goss[31] on phoria and the accommodative amplitude; Ebenholtz[32] on accommodative hysteresis; Green[33] on the problems of the external musculature; Rabin et al.[24] on ocular abnormalities, etc. As indicated in the model, the environmental risk characteristics are those related with (a) periods of time in confined areas, (b) excessive, sustained close work, (c) working with insufficient light (reading) and (d) reduced outdoor activities (sports).

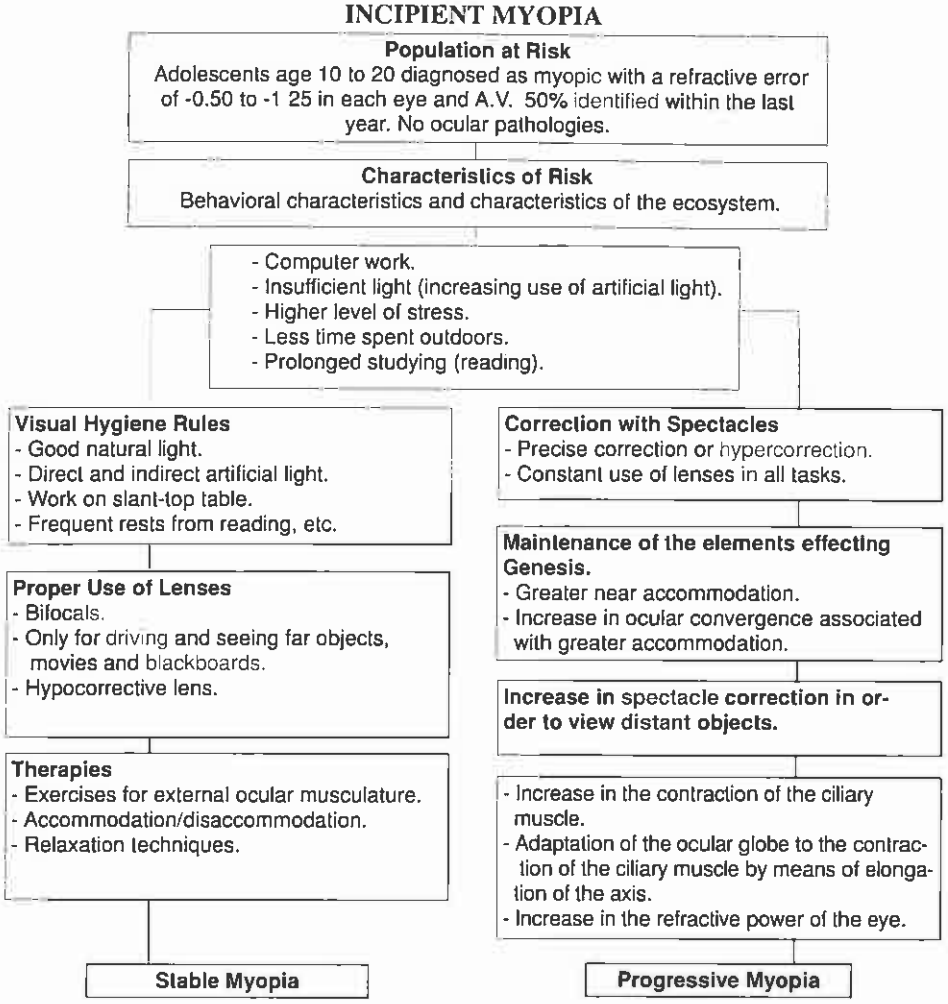


*Figure 2. Myopia maintenance and increase model. The chart shows the actions which could slow the increase of refractive error in an ecosystem with risk features.*

Once the population at risk has been identified, preventive steps are aimed at improving seeing conditions and reducing general muscular tension in the eye, especially ciliary muscle tension. This may be achieved in a number of ways (see left side of Figure 2).

a. Working in well-lighted conditions
b. Hypocorrection using negative lenses for seeing distant objects and non-correction for close work so as not to increase ciliary contraction
c. Eye exercises (visual skills) concentrating on relaxation, ocular movements, accommodation/disaccommodation
d. Certain rules of procedure for performing close work
e. Muscle relaxant drugs, relaxation techniques.
f. Exclusive use of lenses for distant activities

On the other hand, it is inferred from the model and has been acknowledged by some authors that corrective lenses in children, especially hypercorrective lenses, cause a rapid increase in refractive error in such a way that the increase in myopia seems to be associated with the frequency of examinations.[26,29] When contact lenses are used, a reduction in the increase in myopia generally seems to result, though there is no one explanation of this fact.[34,35]

The right side of Figure 2 shows a model explaining how *myopia is main-*

*tained and, under certain conditions, increases* after the eye elongation process has already caused incipient myopia. According to the model, myopia increases because of the following factors: the first is the degree of correction. The second is the use of lenses for close work. It must be pointed out that, with glasses, the crystalline lens contracts even further during close work.

Figure 1 established that the mechanism responsible for myopia is the sustained increased ciliary contraction. This is caused by the demands of the ecosystem and the eye's limited characteristics. Our hypothesis is that all actions (treatments) involving increased sustained ciliary muscle contraction or merely increased contraction will cause the myopia to progress. On the other hand, therapies which reduce ciliary stress will stabilize the myopia.

Though, of course, the steps drawn from both models (Figures 1 and 2) seem clear and have become popular among behavioral optometrists and some ophthalmologists, that does not mean that there is a body of research supporting the model, much less the effectiveness of preventive rules in slowing the progression of myopia.[36] That is why, in addition to experimental work on animals to evaluate the importance of the variables mentioned in the model, two parallel lines of research should be initiated.

The first is the continued epidemiological study of a population at risk and a population not at risk in accordance with the model, allowing us to run transverse and longitudinal studies on the sample. This would, at any rate, allow us to make individual functional analyses related to ocular variables and the individual's behavioral styles.

The second line of research would be to study the effectiveness of the preventive rules referred to above, starting the process with individual preventive intervention and analyzing sets of cases, then testing its efficiency in community-wide prevention. The work of Avetisov,[29] Streff,[37] and Santacreu and Guio[21,38,39] could serve as a sample of research strategies in this field.

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