

Myopia and Culture: Social, Environmental and Educational Changes after Western Colonization

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ABSTRACT

School myopia has developed along with modern Western culture. Recent research has confirmed old ideas that myopia development was related to reading habits. Both defocus and contrast issues of black letters under white background are probably related to the myopigenic effect of long periods of reading. Besides, the change from a rural life mainly outdoors, to living indoors with artificial lighting, is directly related to the industrial revolution and the continuous direction of modernization changes in urban lifestyle. Furthermore, research has shown that this lack of outdoor exposure also produces myopia in school children. Two hundred years ago myopia was not common, but now it arises as a pandemic that may pose a heavy burden of vision impairment in the next generation. The environment in which increasing number of children develop their eyes has changed dramatically, with compulsory education imposed all around the world in the late 20th century; Visually unhealthy habits promoted by education in architecture conditions of windowless schools with artificial lights are probably the root of the recent myopia epidemics. This perspective reviews the main aspects of how modern Western culture has developed with an increased prevalence of myopia in Europeans and influenced changes in Inuit and Chinese in the last 60 years. After this analysis we propose possible educational changes from an intercultural point of view.

Keywords: Myopia; Education; Environment; Rural life; Civilization

INTRODUCTION

Today, the COVID-19 pandemic clearly shows us the effects of the devastation of ecosystems on human health. The diagnosis of an environmental crisis is also a symptom of a crisis of civilization, because in identifying the causes of degradation we find the material and symbolic foundations of western modernity [1]. Let's look at how civilization also brought about poorly known consequences for the collective visual health of different societies in the last 200 years.

Northwestern and Central Europe were the epicenter of the Industrial Revolution from the second half of the 18th century. The invention of the coal-fired steam engine led to the creation of factories not only for textiles and buildings, but also for war armaments, mining, railways, shipping, metallurgy and

automobiles. A huge human migration from the countryside to the city began at that time.

Rural life is known to be very different from urban life. In the past, it was not necessary to be able to read and write to work in the countryside. But machine work, universities, "enlightenment" and "progress" were happening in the cities. Thus, the training in modern moral values, promoted by the political and intellectual elites, and the need for increasingly skilled labor were major forces behind the expansion of the modern school to teach literacy to the new sectors that were joining the social division of labor [2]. Much of the literacy of the population was perceived as a benefit and sought after through a process of struggle, but in many parts of the world it was imposed to other cultures and continues to be a fundamental component of colonization of other cultures [3]. Literacy in western culture was necessary for access to the variety

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of new urban jobs created by the industrial revolution. In this context, the modern school with children grouped by gender and age, with desks and teachers who lecture and impose discipline and values such as competition for top marks, was consolidated and naturalized [4]. Community education – which still survives outside schools in large areas of Western culture in an inclusive and intercultural form – taught the new generations trades such as sewing, cooking, baking, blacksmithing, horticulture, subsistence livestock farming, and the handicraft construction of small two floor houses, but was slowly replaced by the modern school with the formal study needed for the Industrial Revolution. For example in our Latin American context, a few decades after its foundation in 1810, the Argentine Republic passed its first Law of Common Education in 1884, establishing its secular, free, compulsory and state-run form. By 1940, 80% of the population was literate [5,6].

LITERATURE REVIEW

In the 19th century, lighting in homes and public spaces still used vegetable and animal fuels (whales were hunted until they were almost extinct, to provide oil for lamps), but the replacement with petroleum based illumination gave rise to fossil fuel lamps (paraffin, gas, diesel). Then in the 20th century, the use of electricity became widespread, making possible new indoor lifestyles with artificial light based on electric power.

All these changes transformed not only jobs and education, as we have seen in broad terms, but also the multiple dimensions of individual and collective health. The hegemonic conception of health began to have more and more to do with access to medicines, vaccines and urban hospital systems, without sufficient attention's being paid to the fact that the path of urban and industrial economic development which produced some great advances from the Western point of view– also produced great new health problems. Vitamins, serums and antibiotics produced by the newly developed pharmaceutical industry, from the 1920's-1940 began to prolong longevity. But with overpopulation from migration to cities also came epidemics of influenza, pneumonia, and tuberculosis. Rickets (lack of sunlight) and pellagra (lack of vitamin B from eating basically refined rice and wheat) also became epidemic in some parts of the world. The former were associated with living in cramped, dark and poorly ventilated places that were generated in the houses of the new urban conglomerates of the 20th century (with the small windows of that time, built to save heat in the cold northern hemisphere winter). These modern urban environmental conditions would also have consequences for visual health as we will now see.

Coincident with the spectacles industry for presbyopia, ophthalmology emerged in England and central Europe at that time. The first book on the specialty, published by Donders in England, dates from 1864 (6)-the same period in which our ancestor Julian Iribarren (1852-1906) started working as an ophthalmologist in Spain. The first ophthalmologists in Denmark [7] and Germany [8] were already arguing in those years, that because of school-based education more and more cases of myopia were appearing. Until then this condition

occurred in only a very low percentage of the population and did not represent a serious public health problem, being presbyopia the most prevalent refractive disorder in that population that was beginning to get older with greater longevity. But the figures for myopia prevalence in some European schools in the 1880's came to be as high as 30%-40% of children, which meant a sudden epidemic [9]. So it was that Cohn in 1886 [8], realizing that this epidemic of myopia (and tuberculosis) in children was associated with a lack of natural light, proposed building schools with large windows. By 1900, following these ideas and recommendations, the "open air schools" movement emerged in Europe. This movement lasted for 30 years and led to the construction of hundreds of schools with open-air walls that were covered in rainy weather. The biggest drawbacks were glare from the sun (although the open walls were oriented northwards), and exposure to inclement weather [9].

Even without much scientific evidence, the epidemic seems to be controlled, as in 1960 Sorsby still reported in England only 8% prevalence of myopia by refraction under cycloplegia, in a population of over 1000 conscript soldiers of 20 years of age taken at random [10]. Sorsby, who was very influential at the time, argued that myopia was genetically caused and he played down the importance of the environment, in this case, light. This widespread concept and the rise of fluorescent tube lighting in the developing light industry after World War II led to the construction of windowless schools with artificial lighting and air conditioned [11]. The light industry was the first, after 1920, to include "programmed obsolescence" in the production of lamps, such that this would produce a rise in the depressed economy of those days [12]. In the 50's, school architects thus solved the previous problems of both glare and heat insulation (11). It would take more than half a century for the idea that school and home lighting was a key factor in childhood eye development to begin to be revived [9].

One very important piece of evidence for the role of environment comes from the severe epidemic of myopia suffered by the Inuit and other native nations of the Arctic, after they were colonized by European and North American nations [13]. In the context of genocide, children were taken from their parents, removed from outdoor community life, and compulsively schooled under inhumane conditions. In these "residential religious schools", which were the scene of gross human rights violations, artificial light and small curtained windows in such cold weather had a dramatic effect. In just ten years, cases of tuberculosis multiplied and the prevalence of myopia rose from 3% to 60%, an epidemic that was recorded by many researchers in Canada and Alaska [13,14].Canada's Residential Schools, from 1960 to 1990, produced a regrettable cultural alienation of Inuit children that has yet to be repaired, in their survivors and their families [15].Arctic ophthalmologists published papers in scientific journals suggesting environmental factors should be at play (intense education system) [14,16,17]. But Sorsby, in readers' letters, fought them hard by arguing for the genetic origin of myopia [18].

Another case of current relevance comes from the recent history of China, one of the world's leading economic nations. In 1960,

a rural country of 667 million people, with less than 40% of their population literate, produced the communist "cultural revolution". It was not until the 1980s, however, that the successive reforms of economic openness to the capitalism that now prevails there led to the rural exodus towards urban sprawl with the consequent increase in the duration and intensity of schooling of the new generations, in a highly competitive social scheme to achieve the best education that can afford in adulthood the money the increasing costs of the contemporary Chinese urban lifestyle with expensive apartments, private tutorial classes for kids and high cost non-covered medical exams. Thus, thousands of cities were enlarged in the country, doubling its population to date and creating hundreds of thousands of schools for young people born since 1980, only 40 years ago. The prevalence of myopia in the Chinese population was only 22% in the first population study around year 2000 for subjects aged 40+ who were children in 1960 [19]. When they were studied, a 50% prevalence of cataract which produces lens related myopic shifts was present, so the prevalence of true school myopia should have been about 10%-15% in China in 1960, similar to that of Sorsby in England [19]. But today there is an epidemic of myopia even more pronounced than that of the Inuit [20].

This kind of cultural and urban change took place two decades earlier in Singapore, which became independent in 1963 and recorded the increase in myopia in military conscripts since 1980 [21,22]. In just 20 years, cities of low two-story houses were transformed into large cities with crowded blocks of 40-story skyscrapers. Today, in the schools of the economic powers known as the "Asian tigers", children from age 3-4 study from Monday to Saturday for more than 8 hours a day and 3-4 more hours a day of extracurricular tutorials have also been added, for maximum performance in the National Universal Entrance Examination for Higher Education when they are 15 years old. Access to the best universities and the best-paid jobs depends upon success in this exam. And today a huge proportion of young people in China, Singapore, Hong Kong, Taiwan and Korea go on to universities, so that already 50% of the total population has had tertiary education. Scarce data gathered about indoor lighting in the schools of China show not more than 150-300 lux for classrooms, whereas accepted Western standards suggest 500-800 lux for schools and workplaces [23]. A recent study in Israeli kindergarten children aged 5-6, who stay since age 3-4 in their classrooms 8 hours a day from Sunday to Friday, 11 months a year with low outdoor exposure during breaks, has found that their hyperopic reserve (that protects them from myopia development) is lower when being raised in low illuminated classrooms of 350 lux [24]. This promising study should be rapidly replicated to confirm that indoor illumination also plays a role in refractive development.

In contrast, measurements taken in one of the many old schools with large windows, built in Argentina between 1880 and 1930 (Escuela Granaderos de San Martín on land ceded by the Municipal Hippodrome of the Autonomous City of Buenos Aires) still influenced by the hygienist model of Cohn's schools, show that the illuminance is 800 to 1200 lux (Figure 1) [15].



Figure 1: Big windows in the Granaderos School, Buenos Aires, Argentina, built in the years 1920s.

These differences in classroom illuminance may be one of the many reasons why young people in China, Singapore and Korea today have a prevalence of myopia of 85%-90%, while in Argentina it is no more than 10%-20% [25]. In our country, 85% of education takes place in state schools, but instead of spending 8-10 hours per day, as in China's public schools, here they spend mostly 4 hours per day schedule. This probably adds to the differences between environmental conditions in Asian cities and those in Argentina. A recent study has linked higher myopia rates associated with living on the lower, less brightly lit floors of mega high-rise developments in overcrowded areas of East Asia [26]. The subtropical monsoon climate, with several months of harsh winters with snow and several months of scorching heat with heavy rainfall, may also lead children in industrialized China to spend more and more time in artificially lit air-conditioned or heated indoor urban environments. In addition, intense air pollution in the mentioned Asian cities could lead their people to avoid being outdoors. These last two environmental variables have not been explored to our knowledge in myopia research.

These differences in climatic, urban and lifestyle conditions could mean that our Argentinian children still have more contact with natural light, in their homes, neighbourhoods and outdoors in squares, gardens, sports centers, and clubs doing various recreational activities throughout our country. This is also the case in countries such as Australia, where studies are already being carried out to explore the relationship between myopia prevalence and outdoor exposure, in order to prevent what has happened in China. In large Asian cities, children spend only 2-3 hours per week outdoors while in Australia they spend 14 hours per week outdoors [27]. These differences in education, work, environment, and lifestyles are as great as the differences in economic and industrial development at least compared to Latin America, and they all have implications for eye health. China and the other Asian industrial powers, having a very high prevalence of high (pathological) myopia (about 20% of the young population), will probably reach 5%-10% of the adult population with severe vision problems in 20-30 years [28]. This may lead in the coming decades to a large population with severe vision problems and disability due to myopic maculopathy, which implies a serious public health problem [29]. All this is ultimately caused by the aforementioned economic, socio-cultural, educational and environmental changes, contrary to the genetic causes that Sorsby defended with blind vehemence. Actualizing in our field the long-term debates of nature/culture, genes/environment, which several

times uncovered racist and reductionist prejudices over very complex phenomenon, we know today that only 2-3% of myopia (high myopia, more negative than -5.00 diopters) is hereditary i.e., due to the influence of specific genes [30,31]. To this we can add more than 300 different genes homogeneously distributed in the whole population that in combination could explain less than 20% of phenotypic expression of mild and moderate myopia [30,31]. The remaining prevalence must be explained by environmental factors. It would be very difficult to sustain genetic hypotheses today, to explain the historical evolution of those myopia epidemics mentioned above in such a short time when gene pools do not vary rapidly.

DISCUSSION

There is now ample scientific evidence that promoting outdoor schooling for children in Asian schools for only two hours or more per day reduces the prevalence, incidence and progression of myopia [32,33]. School architecture, home architecture, and urban planning in general should also be reviewed to achieve greater illuminance in indoor spaces, as they have probably created environments that may be unhealthy for the childhood visual development of millions of children all over the world. There are also sophisticated methods to alleviate the problem at the individual level, such as specially designed eyeglasses with peripheral defocusing. There are also contact lenses designed on the same principle. Diluted drops of an ancient plant-based alkaloid, atropine, also slow the progression of myopia effectively, without complications and at low cost [32].

Recently, thanks to recent research of the German scientist Frank Schaeffel [34], we also have understood new aspects of the relationship between myopia and the specific environmental-socio-cultural factor of reading. The fixation of the eye on black symbols on a white background feeds back into a metabolic mechanism that makes the eye grow faster in animal models, thus possibly helping in myopia development in reading cultures. However, the opposite contrast of white lettering on a black background does not produce this effect, which is already leading to changes in the use of colors and contrasts in digital devices despite the fact that their efficacy is not yet proven. Interestingly, the printing of new books per capita is climbing steadily since 1960 in Europe and since 1970 in East Asia, while the world global production of books doubled from 1995 to 2000 reaching more than 2 million of printed books per year [35].

However, given the complexity of the intertwined dimensions of this aspect of visual health, in our view, the architectural, curricular, and environmental organization of the education system should be rethought to counterbalance the dominant academic teaching format, with its high myopigenic load, whose maximum expression was the horror perpetrated on the Inuit and, more specifically, the strong school pressure on Asian children that results in long-term diseases such as high myopia with complications at an adult age.

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CONCLUSION

In the field of the education system, which still has a strong imprint linked to colonization and the global expansion of the ideology of Western modernity, there are transformative experiences through re-exporting the links with popular and community education. Broadening these dialogues, our societies could explore not only other school architectures, but also other uses of time, space, and the physical spacing of people, as well as other teaching and learning dynamics that educate from diverse and varied intercultural values. This extends school education to the multiple human dimensions that modernity has reduced only to illustration. Knowledge from art, health care and environmental care, combined with the critical appropriation of new technologies and many other pedagogical fields to be recovered and explored, should allow the development of collaborative group learning and teaching projects. Such endeavors do not imply a virtual education or a high myopigenic reading load in indoor conditions, but rather the addition of outdoor education, schools in dialogue with their territories, the re-valuation of the rural environment, and environmental recovery in the urban environment. The environmental course of Latin American societies in this sense looking in the mirror of the visual health of contemporary hyper-industrialized societies, which are responsible for the environmental and health crisis, is still open, and we can continue to think about it in order to transcend civilizing models that have clearly unsustainable costs in terms of health and the environment. It is well known that we can learn from our mistakes, so as not to repeat history.

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