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Original Article

Efficacy of predictive holistic indicator for prevention of damage to visual health

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Abstract: Throughout the years, more factors have been added to the visual affectation, with environmental, economic, and cultural factors considering the principle ones. Therefore, the importance of this study, with a systemic focus, is to apply a predictive holistic indicator based on the factor that affect visual health in patients of the Optometry Clinic, Interdisciplinary Health Sciences Center (CICS), Santo Tomás Unit (UST), of the Instituto Politécnico Nacional (IPN), México, with a universe of 50 patients who attended a first evaluation at which tests were carried out of visual acuity, Schirmer II test, and biomicroscopy; also, we gathered information through the application of a questionnaire designed to generate the prediction of the visual-health factor of each factor. From the latter, we obtained a holistic index of 50.90% as visual-health prognosis, which fell within a range of fair; later, at 6 months, we performed a second optometric evaluation to find the relationship between the number of patients categorized in each of the visual-health indicators and by gender during the first and second clinical evaluation, finally, we carried out the statistical significance test by means of a *p* value [p_1-p_2] in terms of $Z_{\alpha\text{-}0.05}$, in which we found, in both genders and in the different visual indicators, a lesser *p* value with respect to $Z_{\alpha\text{-}0.05}$. This indicates that there was no statistical significance; thus, we can conclude that the predictive holistic indicator is functionally given that its prognosis was fulfilled.

Keywords: Predictive holistic indicator, factors, visual health

Introduction

An indicator is a value that permits to know the magnitude or size of something in relation to a whole. Through a percentage-form holistic indicator, a prognosis of visual health can be performed based on the affectation of the factors-to-evaluate. This is carried out by means of a mathematical model that results from multiplication of each of the individual indicators of each factor. Thus, this is categorized according to the holistic indicator and aids in predicting the behavior of the visual state [1].

In data reported by the Mexican National Institute of Statistics and Geography (INEGI) in 2010, of the 112,336,538 inhabitants of the Mexican Republic, 43.24% of the population, that is, 48,575,560 required optometric services in Mexico [2]. In worldwide terms, uncorrected refraction errors (myopia, hypermetropy, astigmatism, and presbyopia) constitute the most important cause of visual disability; for this reason, this population would have a visual improvement with the use of eyeglasses [2]. Due to the latter, in 2003 the World Health Organization (WHO) requested from each country a proposal to avoid blindness that was denominated 20/20 Vision; thus, on March 4, 2005, Mexico created Nacional Council for the Prevention and Treatment of Visual Diseases [3].

For this reason, it is important to carry out optometric tests, such as Visual Acuity (VAS), which evaluates visual capacity with or without eye-

Table 1. Percentage of affection according to the individual indicators of each factor

Factor	Percentage of affection	Percentage of individual indicator
Tecnological	22%	78%
Enviromental	2%	98%
Economic	10%	90%
Cultural	26%	74%

glasses, as well as biomicroscopy with the slit lamp, which evaluates the absence or presence of some ocular pathology, and to conducted the Schirmer II test that, with the aid of filters, quantifies the amount of lachrymal secretion [4, 5].

There is evidence concerning that persons who utilize computers for >3 h daily are unaware of the damage implied for human health by their excessive use. Little by little, these individuals begin to detect symptoms in their organism; there is an estimate that between 50 and 90% of the users of visual devices suffer from ocular fatigue, red eyes, irritated eyes, dry eyes, eyelid tension and heaviness, tearing, a burning sensation, blurry vision, and difficulty in focusing on objects at a distance [6-8].

The cornea and conjunctiva are the anterior layers of the ocular globe, which is charged with the absorption of UltraViolet (UV) radiation. Excessive exposure to solar light can be a risk factor for ocular diseases and the reduction visual performance. Thus, UV radiation plays an important role in the pathogenesis of some pathologies of the eye. This implies a complete process of cellular death, matrix remodelling, Oxidative Stress (OS), and inflammation [9, 10]. Studies indicate that a daily exposure of 5 h within a minimal lapse of 5 years predisposes to the appearance of pinguecula and subsequently pterygium [11].

The investigation carried out in 2015 by OXFAM México (Oxford Committee for Famine Relief) published, within the framework of the lancing of the "IGUALES" Campaign, evidence of the importance of combating economic inequality, in that more than one half of Mexicans (54.4% of the population) remain under poverty conditions, i.e., >55 million persons. Poor distribution of economic resources has limited the economic growth of the country and has plunged it into a vicious circle of poverty [12, 13].

Institutions such as the CICS UST of the IPN and its Optometry Clinic recommend the carrying out of the visual examination every 6 months or annually, according to the case. Also, the Specialist in Ophthalmology and Retina Services, Dr. Bueno-García recommends presenting for clinical evaluation with this same regularity due to that with the passage of time, more factors are added to the damage of vision [14, 15].

The objective of this work was to apply the predictive holistic indicator of visual health in the population attending the CICS UST Optometry Clinic. The predictive holistic indicator was previously validated in an article of investigation in the year 2016 [1].

Methodology

The study was carried out at the Optometry Clinic of the CICS UST of the IPN. The study was evaluated and approved by the Research Committee and by the Ethics Committee of the Escuela Superior de Medicina (ESM-IPN) with approval numbers CI-01/17-12-2015 and CE-01/16-12-2015, respectively.

Sample size and general procedure

A sample size of 50 patients complying with the following inclusion criteria: indistinct gender and age between 20 and 40 years, and the following exclusion criteria: patient with autoimmune disease; pregnant patient, and patient with some chronic, non-transmissible disease. On complying with the inclusion and exclusion criteria, the patient was submitted to a series of steps to obtain the prediction of the visual state based on the classifier of the holistic indicator. Two visual evaluations were performed: optometric tests, and data were gathered by means of a questionnaire to generate the prediction of the patient's visual health. Six months later, a second evaluation of the optometric tests was conducted to prove whether the prediction of the holistic indicator complied with the first results.

Obtaining the holistic indicator

First, we applied a questionnaire to patients of the CICS UST. From this questionnaire, we obtained the individual data of the four factors (technological, environmental, economic, and cultural), as previously reported [1]. On the

Table 2. Classifier holistic indicator

Factor range	Share of
100% to ≥90%	Excellent. The values do not produce alteration.
≥80% to <90%	Good. They are good values but have little affection.
≥65% to <80%	Acceptable. The values are acceptable but the condition is significant.
≥50% to <65%	Regular. The levels refer to damage present in the visual health from exposure to the factor.
Factor <50%	Unacceptable. The condition for exposure or factors is present and can be further developed.

Table 3. Indicators of visual health

Visual acuity[4]	Schirmer II Test[5]	Biomicroscopy[5]
Normal 20/20	<10 mm	Absent
Mild 20/25-20/40	11-15 mm	Present
Moderate 20/50-20/80	16-20 mm	
Severe 20/100-20/400	21-25 mm	
	26-30 mm	

Adapted: Hernández-Luna, 2003 [4]; Kanski, 2009 [5].

other hand, with these data we applied the holistic model indicator of visual-health affectations with the percentage values of each individual indicator described in **Table 1** [1], utilizing the following mathematical holistic-indicator model of visual health conditions:

(Technological F. %) × (Environmental F. %) × (Economic F. %) × (Cultural F. %) = Holistic indicator

Last, we classified the visual-health state as revealed in **Table 2** [1].

Evaluation of visual health through optometric tests

Optometric tests were performed to evaluate visual health by means of the following three tests: visual acuity; the Schirmer III test, and biomicroscopy. Next, we described these briefly: Visual acuity was determined according to the technique reported by Hernández-Luna [4], which consists of measuring visual acuity at a distance both molecularly and binocularly, in order to make the conversion at 6 meters and to categorize this according to the classification depicted in **Table 3**.

Lachrymal secretion through the Schirmer II test according to Kanski [5] consisted of administering the patient with an ophthalmic anesthetic and placing a filter paper over both eyes and, according to the value, this is classified in agreement with **Table 3**.

Last, according to that reported by Kanski [5], the presence or absence of pinguecula was determined by means of the biomicroscopy test, which is supported by a slit lamp in order to be able to observe the anterior part of the eye.

Statistical analysis

As the statistical test, we applied the *p* value, in which statistical significance is considered in the following manner: if [first evaluation (p_1)-second evaluation (p_2)] is greater than the product of 1.96 ($Z_{\alpha\text{-}0.05}$) multiplied by the Standard Error (SE), it was concluded that the difference is significant [16, 17]. The statistical tests work as follows: the magnitude of the difference between the group to be compared for each test (first evaluation (p_1) -second evaluation (p_2)) is checked; where:

p_1 = First evaluation/No. patients;

p_2 = Second evaluation/No. patients;

p = [p_1 + p_2]/2;

The standard error is calculated as follows: √p (1-p) (1/n1 + 1/n2);

Standard error multiplied by Zα-0.05.

Results

On applying the holistic indicator model, that is, multiplying the percentage values of the individual indicator for each factor in **Table 1**, we obtained a percentage of 50.90% that, according to the holistic indicator classifier of **Table 2**, classifies visual health as at a fair state. The latter indicates the presence of the affectation of the factors evaluated due to direct exposure to visual devices, the UV factor, medium or low economic income, and the lack of preventive culture in their visual-health sector.

According to the first- and second-clinical-evaluation visual acuity test, in their statistical sig-

Table 4. Comparison of visual acuity of the first and second clinical assessment and its significance

	1st evaluation (n)	Holistic Indicator	2nd evaluation (n)	$[p_1-p_2]$	$Z_{\alpha-0.05}$
Women					
Normal 20/20	5	Excellent 100% to ≥90%	4	0.0286	0.1568
Mild 20/25-20/40	7	Acceptable ≥65% to <80%	7	0	0.1874
Moderate 20/50-20/80	7	Regular ≥50% to <65%	6	0.0286	0.1822
Severe 20/100-20/400	16	Unacceptable <50%	18	-0.0571	0.2342
Mens					
Normal 20/20	1	Excellent 100% to ≥90%	1	0	0.1785
Mild 20/25-20/40	5	Acceptable ≥65% to <80%	5	0	0.3374
Moderate 20/50-20/80	4	Regular ≥50% to <65%	3	0.0667	0.3027
Severe 20/100-20/400	5	Unacceptable <50%	6	-0.0667	0.3449

Table 5. Comparison of the schirmer II test of the first and second clinical evaluation and its significance

	1st evaluation (n)	Holistic Indicator	2nd evaluation (n)	$[p_1-p_2]$	$Z_{\alpha-0.05}$
Women					
26-30 mm	0	Excellent 100% to ≥90%	2*	-0.0571	0.0781
21-25 mm	3	Good ≥80% to <90%	5	-0.0571	0.1491
16-20 mm	4	Acceptable ≥65% to <80%	4	0	0.1491
11-15 mm	11	Regular ≥50% to <65%	6	0.1429	0.2009
<10 mm	17	Unacceptable <50%	18	-0.0286	0.2343
Mens					
16-20 mm	1	Acceptable ≥65% to <80%	1	0	0.1785
11-15 mm	3	Regular ≥50% to <65%	4	-0.0667	0.3027
<10 mm	11	Unacceptable <50%	10	0.0667	0.3280

*Less exposure to visual devices.

nificance and classification based on the holistic indicator in **Table 4**, we found that, in feminine gender in the unacceptable range, was 16 patients in the first evaluation vs. 18 patients of the second evaluation, that is, in this test there were no significant changes. This was due to that in statistical test with respect to the *p* value in the unacceptable range was -0.0571 and multiplication of ($Z_{\alpha-0.05}$), which for the SE was 0.2342. On the other hand, in masculine gender, the result in the unacceptable range in the first evaluation was five patients vs. six patients in the second evaluation, while in the statistical test, there was a *p* value of -0.0667 and multiplication of ($Z_{\alpha-0.05}$) by the SE was 0.3449. These results can be due to that patients continued with the same habits.

On the other hand, among the first- and second clinical-evaluation results of the Schirmer II test, their statistical significance and classification based on the **Table 5** holistic indicator was obtained, finding that the number of patients among women within the unacceptable range in the first evaluation was 17 patients vs. 18 patients of the second evaluation. In this test, there is no statistical significance due to that regarding the *p* value within this range, this was -0.0286 and multiplication of ($Z_{\alpha-0.05}$) by means of the SE was 0.2343. Similarly, in the range considered excellent, there was an increase of two patients. These favorable data in lachrymal production can be due to the patients' change of habits, that is, a lesser exposure to the visual devices. With regard to the masculine gender, the result in the unacceptable range in the first evaluation was 11 patients *vs.* 10 patients in the second evaluation, while the statistical test there was a *p* value of 0.0667 and multiplication of ($Z_{\alpha-0.05}$) by the SE was 0.3280, without statistical significance.

Last, the results of the biomicroscopy test of the first and second clinical evaluation, its sta-

Table 6. Comparison of the biomicroscopy of the first and second clinical evaluation and its significance

	1st evaluation (n)	Holistic Indicator	2nd evaluation (n)	$[p_1-p_2]$	$Z_{\alpha\text{-}0.05}$
Women					
Absent	34	Acceptable 100% a ≥90%	33	0.0286	0.0949
Present	1	Unacceptable <50%	2	-0.0286	0.0949
Mens					
Absent	15	Acceptable 100% a≥90%	15	0	0

tistical significance, and its classification based on the holistic indicator in **Table 6** in feminine gender within the unacceptable indicator range in the first evaluation was one patient vs. two patients of the second clinical evaluation, with a *p* value of -0.0286 and multiplication of ($Z_{\alpha\text{-}0.05}$) by the SE was 0.0949. On the other hand, no change presented in masculine gender, that is, the 15 patients found within the acceptable range in the first clinical evaluation are the same patients during the second evaluation. That is, no statistical significance was found in this test.

Discussion

In 2011, Hoffelt and collaborators evaluated the risk factors for suffering from glaucoma, such as age, ethnicity, gender, familial history of glaucoma, and familial history of diabetes. By means of a telephone interview, we gathered the patients' demographic, medical, and socioeconomic information; later, for candidates with a posible risk for having glaucoma, they were referred to an Ophthalmologist for a vision examination, during which we applied to them a questionnaire form, with a value of 1-10 for responses; with a total score of 4 or more (≥4), a high risk is considered for glaucoma, an already established prevalence scale that aids in obtaining an average score, thus establishing whether the patient is at risk for having glaucoma. The Ophthalmologist fills out a blank evolution form that indicates whether the patient had regular visual examinations, with the results of the visual evaluation determining the factors associated with glaucoma [18].

On the other hand, Sandín in 2003 presented an analysis on the current concepts of stress, focusing on social factors, defining in detail three different stressors as follows: life happenings (recent stress); role stress (chronic stress), and daily annoyances (daily stress); the author mentioned that these social stressors individually cause a degree of stress, but he also refers that they act in an interrelational manner, in that they mutually can be influenced by, for example, life happenings that leads one to chronic stress of viceversa. Sandín carried out this analysis through theoretical works and critically evaluated each of the stressors that present in the daily life of humans, concluding that these factors independently cause disturbances in health associated with stress give rise to damage, due to the interrelationship that exist among these factors [19].

Likewise, in 2011, Patiño Villada and coworkers conducted a study in which the authors evaluated the prevalence of cardiovascular risk factors in a Colombian population through the application of an especially designed questionnaire, in addition to carrying out tests to measure blood cholesterol, triglycerides, glucose, and High- (HDL) and Low-density (LDL) lipoproteins, The authors took measurements of blood pressure, abdominal circumference, height, and weight. On performing their methodology and statistical analysis, they reported that the greatest factors for vascular risk were low physical activity, central obesity, dyslipidemias, smoking, metabolic syndrome, and obesity related with Body Mass Index (BMI), given that they are related with the questionnaire responses that evaluate the factors and the results of the clinical tests [20].

Therefore, the previous works, as well as this work, focus on the interrelationship of the factors, due to that the authors coincide on that each element causes independent damage. But, on relating these among themselves, they cause a greater magnitude of the same. Thus, the difference among this investigation and the previous researches is that the present one is based on the General Systems Theory (GST), which offers a better result due to that all of the parts are studied that interrelate among themselves and that they comprise a whole. In the same manner, the proposal of this work was to evaluate the technological, environmental, economic, and cultural factors in holistic way, this proposal integrating each of these and studying them as a whole, that is, the damage of each factor is considered accumulatively, finding the interrelationship between each of the factors evaluated, in that they directly influence the visual health of the patients seen at the CICS UST of the IPN, through the association among the optometric tests, this relation as the ocular symptomatology and changes in visual acuity (**Table 4**). On the other hand, UV exposure of >5 h favors the presence of some pathology of the ocular conjunctiva [11], a factor in which we also found a small increase in the visual affectation during the second evaluation in women (**Table 6**). We also found certain dependence between economic and cultural factors, in that if there is not a good economic income, patients do not attend their visual appointments regularly. This can generate the patients' presenting diminution of visual acuity, increases in the graduation of their prescribed eyeglasses, and the appearance of ocular pathologies in the short and long term (**Tables 4** and **6**).

Finally, on observing that the *p* values in the different categories of visual acuity, the Schirmer II test, and biomicroscopy were $<Z_{\alpha\text{-}0.05}$, no significant statistical difference was found, this denoting that the indicator fulfilled its prognosis in each of the visual-health indicators. Therefore, we are able to conclude that the functionality of the holistic indicator is well-aimed, because the visual-health prognoses in each of the qualifying ranges of each indicator were maintained. This can have been due to that, given that during the second clinical evaluation the habits of each of the patients were not modified, that is, modifications were not indicated to the patients in terms of the exposure time to the technological and environmental factors, nor was the frequency indicated to them of when they should go for a visual-examination appointment. On the other hand, the study could be proposed to be carried out at between 9 and 12 months to observe whether during this time lapse some change was obtained in the proposed holistic indicator, or whether one was able to observe solely by means of the change in the population's habits.

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Disclosure of conflict of interest

None.

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References

[1] López-De-León EO, Morales-González JA, Ramos-Perez S, Madrigal-Santillan EO, Pérez-Pasten R, Fregoso-Aguilar T and Morales-González A. Holistic indicator model for predicting factors that generate visual health affections. Int J Clin Exp Med 2016; 11: 22004-22011.

[2] INEGI 2016, Instituto Nacional de Estadísticas y Geografía. Available online: www.inegi.org.mx/ (accessed on 09 September 2016).

[3] Optometría México. Available online: www.optometriamexico.org/ (accessed on 20 September 2016).

[4] Hernández-Luna CP, Barrera-Santos DC, Guiza-Segura C, Rodríguez-Malagón JP, Ernesto-Ludeman W and Gómez-Montaña SP. Estudio de prevalencia en salud visual en una población escolar de Bogotá, Colombia 2000. Ciencia & Tecnología para la Salud Visual y Ocular 2003; 1: 11-23.

[5] Kanski J. Oftalmología Clínica. Sexta Edición. España: Elsevier; 2009. pp. 46-51

[6] Pérez-Tejeda AA, Acuña-Pardo A and Rúa-Martinez R. Repercusión visual del uso de las computadoras sobre la salud. Rev Cub Salud Pública 2008; 34: 1-8.

[7] del Río-Martínez JH and González-Videgaray M. Trabajo prolongado con computadoras: consecuencias sobre la vista y la fatiga cervical. SEMAC 2007: 26-28. [IX congreso de ergonomía, 26-28 abril, 2007].

[8] Bansal Y and Moudgil T. Computer Visión Syndrome. Int J Inn Res Dev 2014; 3: 276-279.

[9] Liou JC, Teng MC, Tsai YS, Lin EC, Chen BY. UV-blocking spectacle lens protects against UV-induced decline of visual performance. Mol Vis 2015; 21: 846-856.

[10] Moreno-Domínguez JC, Perea-Ruiz CA, Suárez-Herrera F y Sanfeliz-Yebra N. Prevalencia y factores de riesgo para el pterigium en la población de “Hebi”: Henan provincia, China 2009. Rev Ciencias Médicas 2011; 15: 43-58.
[11] Sekelj S, Dekaris I, Kondza E, Gabric N, Predovic J and Mitrovic S. Ultraviolet light and pterygium. Coll Antropol 2007; 31: 45-47.
[12] OXFAM México (Oxford Committee for Famine Relief). Available online: www.oxfammexico.org (accessed on 15 september 2016).
[13] Secretaria de Desarrollo Económico del Gobierno del Distrito Federal. Política de Recuperación del Salario Mínimo en México y el Distrito Federal. Available online: www.salarioscdmx.sedecodf.gob.mx (accessed on 7 August 2016).
[14] CICS UST. Instituto Politécnico Nacional. Available online: www.cics-sto.ipn.mx/(accessed on 15 november 2016).
[15] Bueno Garcia RA. El impacto de las nuevas tecnologías en la visión. Ciudad de México, 11 de Octubre del 2011. [Conferencia en el Día Mundial de la Salud].
[16] Manterola C y Pineda V. El valor de “p” y la “significación estadística”. Aspectos generales y su valor en la práctica clínica. Rev Chil Cir 2008; 60: 86-89.
[17] Rivas F. El significado de la significancia. Biomédica 1998; 18: 291-295.
[18] Hoffelt Z, Fallon S, Wong BA, Lucas B, Coleman AL, Mills RP, Wilson R and Mansberger SL. Glaucoma public service announcements: factors associated with follow-up of participants with risk factors for glaucoma. Ophthalmology 2011; 7: 1327-1333.
[19] Bonifacio-Sandín. El estres: un análisis basado en el papel de los factores sociales. Int J Clin Health Psychol 2003; 3: 141-157.
[20] Patiño-Villada FA, Arango-Vélez EF, Quintero-Velásquez MA and Arenas-Sosa MM. Factores de riesgo cardiovascular en una población urbana de Colombia. Rev salud pública 2011; 13: 433-445.