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CONCORDANCE BETWEEN TWO QUESTIONARIES FOR THE DIAGNOSIS OF DIGITAL EYE STRAIN IN STUDENTS OF A UNIVERSITY IN PERU

CONCORDANCIA ENTRE DOS ENCUESTAS PARA EL DIAGNÓSTICO DE FATIGA VISUAL DIGITAL EN ESTUDIANTES DE UNA UNIVERSIDAD EN PERÚ

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ABSTRACT

Objective: To obtain the frequency of digital visual fatigue (DVF) using two questionnaires among students of a private university in Lima, Peru; to estimate the degree of agreement between both methods. **Methods:** A cross-sectional study was conducted in a sample of 345 participants over 18 years old, students of a university in Lima, Peru and who completed the data collection instrument. The two methods used for the measurement of DVF were the Hayes questionnaire, which defines a positive case for DVF with a score equal to or greater than 20; and the Seguí CVS-Q questionnaire, which defines a positive case for DVF with a score greater than 6. The Cohen's kappa coefficient with its 95% confidence interval was estimated to measure the overall agreement and by strata. **Results:** The Hayes questionnaire identified 167 (48.4%) participants with a presumptive diagnosis of DVF, the Seguí questionnaire identified 247 (71.6%) students. In the concordance analysis, Cohen's Kappa coefficient was 0.45 (95%CI; 0.37 - 0.53) ($p < 0.01$) in the overall analysis, considered moderate. **Conclusion:** The degree of concordance between both methods was moderate, the Seguí instrument identified a higher proportion of university students with DVF.

Keywords: Asthenopia; Self Report; Vision Screening; Surveys and Questionnaires; Eye Manifestations. (Source: MESH-NLM)

RESUMEN

Objetivo: Obtener la frecuencia de fatiga visual digital (FVD) mediante dos cuestionarios entre los estudiantes de una universidad privada en Lima, Perú; para estimar el grado de concordancia entre ambos métodos. **Métodos:** Se realizó un estudio transversal en una muestra de 345 participantes mayores de 18 años, estudiantes de una universidad en Lima, Perú y que completaron el instrumento de recogida de datos. Los dos métodos usados para la medición de FVD fueron el cuestionario de Hayes que define un caso positivo para FVD con un puntaje igual o mayor a 20; y el cuestionario CVS-Q de Seguí, que define como positivo para FVD con un puntaje mayor a 6. Se estimó el coeficiente kappa de Cohen con su intervalo de confianza al 95% para medir la concordancia global y por estratos. **Resultados:** El cuestionario de Hayes identificó a 167 (48,4%) participantes con un diagnostico presuntivo de FVD, el cuestionario de Seguí identificó a 247 (71,6%) estudiantes. En el análisis de concordancia, el coeficiente Kappa de Cohen fue 0,45 (IC95%; 0,37 – 0,53) ($p < 0,01$) en el análisis global, considerado como moderado. **Conclusión:** El grado de concordancia entre ambos métodos fue moderado, el instrumento de Seguí identificó una mayor proporción de estudiantes universitarios con FVD.

Palabras clave: Astenopia; Autoinforme; Selección Visual; Encuestas y Cuestionarios; Manifestaciones Oculares. (Fuente: DeCS- BIREME)

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INTRODUCTION

More than 20 years ago, a syndrome has been described that encompasses several ocular discomforts associated with the use of devices with digital screens [1] this condition is known as visual computational syndrome [2] or digital visual fatigue (DVF) [1]. It encompasses symptoms such as dry eyes, pain, burning and some extraocular symptoms such as cervical pain [3,4]. It is a prevalent problem reported in up to 89.9% of students who spend 2 hours or more a day viewing digital screens [5].

To detect DVF, subjective methods are described, such as self-report surveys, as well as objective methods with various ophthalmological techniques [1]. Among the surveys, one of the first was developed by Hayes et al. that evaluated the severity of DVF in office workers [6]. Various studies used this survey approach to evaluate the severity of symptoms and frequency of the syndrome in various areas [4,7] making it one of the most reproducible surveys to study DVF. Later, Seguí et al. described another survey for the presumptive diagnosis of DVF [8]. There are more surveys, created by different authors and designed for different age groups [9,10].

Due to the Covid-19 virus pandemic [11] many students carried out their education virtually, increasing the use of technology [12] and making them a particularly vulnerable population for DVF. Currently, there is no clear definition of DVF. Evaluating prevalence is a challenge due to the various methodologies used for its identification; the surveys used have different approaches when defining a case of DVF. The heterogeneity between the surveys does not allow an adequate comparison of their frequency among different populations [9]. Therefore, the present study aims to measure the frequency of DVF, with the objective of evaluating the degree of agreement between two surveys used for the presumptive diagnosis of DVF among university students.

METHODS

Scope of study

An analytical cross-sectional observational study was carried out in which 502 students were invited to participate between June and September 2022. The study was carried out at the Universidad de Piura located in the city of Metropolitan Lima in Peru.

Study participants

The target population consisted of 2831 undergraduate students enrolled in 8 careers at the university: business administration (n= 656), industrial and systems engineering(n=464), human medicine(n=403), economics(n=399), law(n=369), psychology(n=340), service administration(n=159) and history and cultural management(n=41). The type of sampling was non-probabilistic by quotas, since the sample was proportional to the total number of students enrolled in each degree program. The inclusion criteria were to provide consent to participate in the study, to be 18 years of age or older, to be undergraduate students at the university, and to fill out the surveys correctly.
The Epidat version 4.2 program was used to calculate the sample size.

A minimum number of 278 participants was calculated taking an expected kappa value of 0.41 (considered moderate) with an expected proportion of 55.83% [7] for the survey by Hayes et al. and 80.6% for the Seguí survey [13] a confidence level of 95%, a precision of 10% and a non-response rate of 10%.

Variables

The main variable was the presence or absence of digital visual fatigue (DVF) determined through the Seguí and Hayes surveys. In Hayes et al's survey, 10 symptoms were measured: Blurred vision at near, intermediate, and far distances; difficulty focusing your eyes; Irritated eyes; dry eyes; visual fatigue; headache; tired eyes and sensitivity to light.

For each symptom, a response was collected with a Likert scale with 7 possible values: none = 0, very little = 1, little = 2, moderate = 3, little bothersome = 4, bothersome = 5 and very bothersome = 6, they were added. the values of each symptom and if the result was ≥ 20, the student was classified as having a positive presumptive diagnosis of DVF. This survey has a Cronbach's alpha range of 0.76 to 0.94 for the assessment of DVF severity. This survey was originally validated in English, there is no validated version in Spanish yet [6,7]. In the Seguí survey, 16 symptoms were measured: burning eyes, stinging eyes, foreign body sensation, tearing, excessive blinking, red eyes, pain in the eyes, sensation of drooping eyelids, dry eyes, blurred vision, double vision, difficulty focusing close

vision, increased sensitivity to light, vision of colored halos, feeling that I now see worse and headache. For each item, responses were collected with an ordinal scale to evaluate frequency: never = 0, sometimes = 1 and frequently = 2. In the presence of any symptom, the intensity of this was rated: moderate = 1 and intense = 2. The presumptive diagnosis of DVF was considered present when the sum of the products of the frequency and intensity of each symptom was > 6. This survey has a sensitivity of 80.0% and a specificity of 83.1%. It has a Cronbach's alpha of 0.78. This survey was originally validated in Spanish[8].

Additionally, variables of history of refractive problems (myopia, astigmatism, hyperopia, dry eye and others not specified) and use of vision corrective measures (permanent lenses, reading and contact lenses and others not specified) were evaluated. Data were collected on age in years completed, sex (male, female and "prefer not to answer"), university career and current year of study (from the first year to the sixth year of study).

Instruments and data collection

The instrument was adapted to a format in Microsoft Excel and Google Forms. The anonymous instrument was applied in printed and digital form. The first part contained questions on sociodemographic factors, history of refractive problems and use of corrective measures. No identifying information such as name or any identity document was requested. The second part contained the Hayes survey and the third part contained the Seguí survey.

All participants were surveyed during university hours on the university campus. Previously, they were given an informed consent that informed them of the purpose of the study and its characteristics.

Statistical analysis

To obtain the final database for analysis, the Google Forms program was used. The printed surveys were entered into said electronic record for subsequent export into a database in the Microsoft Excel program.

The data were processed in Microsoft Excel, for subsequent analysis with the formulas of each survey adapted to said program and thus obtain the frequency of DVF according to the criteria of the Hayes survey and the Seguí survey. Then the data were exported to the Jamovi program in version 2.2.5 for the evaluation of sociodemographic variables and to obtain contingency tables.

Global contingency tables were obtained and stratified by sex, human medicine major, other majors, printed survey modality and virtual survey modality. To evaluate the agreement, the Epidat statistical program in version 2.4 was used, with the agreement analysis tool between two categories. The data obtained from the contingency tables between both survey methods were used and the overall Cohen's kappa index and by strata were calculated, with a confidence level of 95% and a value of $p < 0.01$.

Ethical aspects

The study project was previously approved by the Research Ethics Committee of the University of Piura in April 2022. Informed consent was obtained for all participants. The anonymity of the participants was maintained throughout the development of the study.

RESULTS

502 surveys were collected. 277 surveys were filled out in paper format and 225 in digital format. 157 did not meet the inclusion criteria, 35 of them belonged to the group of respondents using the printed format. A total of 345 surveys were analyzed.

Among those included, the mean age was 20, 1 years (± 1.59). 53.3% (184) of the participants were women. 48.1% (166) of the participants belonged to the human medicine career. 48.7% (168) reported wearing glasses permanently. The most frequent refractive disorders were myopia (49.6%) and astigmatism (40%). The detailed description of the characteristics is shown in the table 1.

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Table 1. Description of the characteristics of the study participants.

Variable	Frequency (n)	Percentage (%)
Gender		
Female	184	53,3
Male	155	44,9
Prefer not to answer	6	1,7
Age		
18-20	220	63,8
21-24	123	35,6
25 ó +	2	0,6
Career		
Human Medicine	166	48,1
Business Administration	52	15,1
Industrial and Systems Engineering	36	10,4
Economy	31	9
Law	24	7
Psychology	21	6,1
Service Administration	10	2,9
History and Management	5	1,4
Year of study		
First	42	12,2
Second	86	24,9
Third	67	19,4
Fourth	95	27,5
Fifth	47	13,6
Sixth	8	2,3
Visual impairment		
Myopia	171	49,6
Astigmatism	138	40
Dry eye	37	10,72
Farsightedness	17	4,93
Other	6	1,7
None	120	34,8
Vision Corrective Measures		
Permanent lenses	168	48,7
Reading glasses	57	16,5
Contact lenses	6	1,7
Other	1	0,3
None	113	32,8
Total	345	100

Regarding the presumptive diagnosis of DVF, the survey by Hayes et al. identified 48.4% (167) as DVF positive, while the Seguí survey classified 71.6% (247) as DVF positive. The most frequently reported discomfort was visual fatigue (83.1%) on the Hayes scale and burning eyes (70.7%) on the Seguí scale. The least reported discomforts were blurred vision at a close distance according to the Hayes scale (45.8%) and double vision on the Seguí scale (23.8%) (Table 2 y 3).

Table 2. Frequency of symptoms according to the Hayes et al. survey to characterize digital eyestrain.

Hayes scale criteria	Rating – n (%)						
	none	Very little	little	moderate	Little annoying	annoying	Very annoying
Blurred vision at near distance	187 (55.12)	58 (16.8)	39 (11.3)	24 (7.0)	9 (2.6)	17 (4.9)	11 (3.2)
Blurred vision at an intermediate distance	114 (33.0)	59(17.1)	58 (16.8)	45 (13.0)	28 (8.1)	29 (8.4)	12 (3.5)
Blurred vision at a distance far away from the screen	82 (23.8)	28 (8.1)	44 (12.8)	33 (9.6)	30 (8.7)	59(17.1)	69 (20.0)
Difficulty or slowness to focus	129 (37.4)	63 (18.3)	62 (18.0)	28 (8.1)	25 (7.2)	28 (8.1)	10 (2.9)
Irritated or burning eyes	78 (22.6)	73 (21.2)	55 (15.9)	60 (17.4)	27 (7.8)	31 (9.0)	21 (6.1)
Dry eyes	152 (44.1)	65 (18.8)	39 (11.3)	37 (10.7)	19 (5.5)	22 (6.4)	11 (3.2)
Visual Fatigue	58 (16.8)	69 (20.0)	46(13.3)	65 (18.8)	32 (9.3)	31 (9.0)	26 (7.5)
Headache	83 (24.1)	69 (20.0)	46(13.3)	48 (13.9)	31 (9.0)	34 (9.9)	34 (9.9)
Fatigued eyes	80 (23.2)	77 (22.3)	42 (12.2)	50 (14.5)	35 (10.1)	37 (10.7)	24 (7.0)
Sensitivity to light	86 (24.9)	78 (22.6)	55 (15.9)	44 (12.8)	27(7.8)	30 (8.7)	25 (7.2)

Table 3. Frequency of symptoms according to the CVS-Q survey by Seguí et al. to characterize digital eye strain.

Seguí scale criteria	Frecuency n (%)			Intensity n (%)		
	Never	Sometimes	Frequently	None	Moderate	Intense
Burning eyes	101 (29.3)	187 (54.2)	57 (16.5)	101 (29.3%)	215 (62.3)	29 (8.4)
Stinging eyes	126 (36.5)	173 (50.1)	46 (13.3)	126 (36.5%)	171 (49.6)	48 (13.9)
Foreign body sensation	213 (61.7)	97 (28.1)	39 (11.3)	213 (61.7%)	104 (30.1)	28 (8.1)
Tearing	157 (45.5)	149 (43.2)	39 (11.3)	157 (45.5%)	160 (46.4)	28 (8.1)
Excessive blinking	235 (68.1)	87 (25.2)	23 (6.7)	235 (68.1%)	85 (24.6)	25 (7.2)
Redness of the eyes	173 (50.1)	137 (39.7)	35 (10.1)	173 (50.1%)	142 (41.2)	30 (8.7)
Eye pain	177 (51.3)	132 (38.3)	36 (10.4)	177 (51.3%)	138 (40.0)	30 (8.7)
Drooping eyelid sensation	217 (62.9)	105 (30.4)	23 (6.7)	217 (62.9%)	106 (30.7)	22 (6.4)
Dry eyes	205 (59.4)	103 (29.9)	37 (10.7)	205 (59.4%)	114 (33.0)	26 (7.5)
Blurred vision	144 (41.7)	123 (35.7)	78 (22.6)	144 (41.7)	140 (40.6)	61(17.7)
Double vision	263 (76.2)	64 (18.6)	18 (5.2)	263 (76.2%)	66 (19.1)	16 (4.6)
Difficulty focusing near vision	228 (66.1)	93 (27.0)	24 (7.0)	228 (66.1%)	100 (29.0)	17(4.9)
Increased sensitivity to light	167 (48.4)	139 (40.3)	39 (11.3)	167 (48.4)	133 (38.6)	45 (13.0)
See colored halos	233 (67.5)	81 (23.5)	31 (9.0)	233 (67.5)	92 (26.7)	20 (5.8)
I feel like I can see worse now than before	147 (42.6)	110 (31.9)	88 (25.5)	147 (42V6)	127 (36.8)	71 (20.6)
Headache	118 (34.2)	148 (42.9)	79 (22.9)	118 (34.2)	151 (43.8)	76 (22.0)

In frequency analysis, 159 (46.1%) of participants tested positive for a diagnosis of DVF by both methods and 90 (26.1%) of participants tested negative for both surveys as well. In the agreement analysis, the kappa coefficient obtained a value of 0.37 (CI 0.2 - 0.5) in the group of women, the lowest of all. The highest kappa value obtained was that of the career analysis, excluding human medicine, with a value of 0.55 (CI 0.4 - 0.7). In the global analysis of agreement, a value of 0.45 (CI 0.4 - 0.5) was obtained. The frequencies of DVF according to the type of survey used and the different values of the kappa coefficient are detailed in table 4.

Table 4. Levels of kappa coefficient between surveys for detection of digital eyestrain by strata and overall.

Group	Frequency of DVF			
	Hayes et al. survey	Seguí CVS-Q Survey	Coeficiente Kappa	CI*
Gender				
Women	111 (60.3)	154 (83.7)	0.37	(0.2 - 0.5)
Men	53 (34.2)	89 (57.4)	0.46	(0.3 - 0.6)
Career				
Human Medicine	77 (46.4)	126 (75.9)	0.41	(0.3 - 0.5)
Other careers†	90 (50.3)	121 (67.6)	0.55	(0.4 - 0.7)
Survey mode				
Virtual	48 (46.6)	69 (67.0)	0.45	(0.3 - 0.6)
Printed	119(49.2)	63 (73.6)	0.45	(0.4 - 0.5)
Global	167 (48.4)	247 (71.6)	0.45	(0.4 - 0.5)

Variables are represented as n (%)*= 95% confidence interval with p-value <0.01
†= Business administration, service administration, law, economics, history and cultural management, industrial and systems engineering & psychology.

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DISCUSSION

This is the first study carried out to evaluate the degree of agreement between diagnostic methods for DVF in university students. We found a degree of agreement of 0.37 in the stratum of women, this indicates an acceptable degree of agreement. In the other strata and the global analysis the values were between 0.41 and 0.6, indicating a moderate degree according to the classification of Landis and Koch [14]. This shows that the measurement of DVF is somewhat complex.

Both surveys assess the reported discomfort of DVF, but they do not take into account the same components to define the syndrome and often do not coincide in some symptoms. In addition, the approach between surveys is different, Hayes et al. uses a Likert scale while Seguí's Rachs-based CVS-Q scale assesses only the frequency and intensity of complaints.

Hayes' method identified 48.4% of students as positive for DVF, the most frequently reported discomfort was visual fatigue. Similar results were obtained in the study by Rashmi et al. where a prevalence of 55.83% was found in students of a health career. They found a higher frequency in women (53.7%) as in our study. However, among the most frequently reported symptoms were headache (73%), dry eye (63.33%) and burning sensation of the eyes (53.3%) [7]. An interesting fact is that within the study by Hayes et al, like our study, they described eyestrain as the most frequent eye symptom (96%) among respondents within an office workplace in 2007 [6]. With Seguí's CVS-Q survey, we found a prevalence of 71.6%, burning eyes was the most frequent symptom among students. Similar results were seen in the study by Gammoh et al. where they evaluated a university population in Jordan in 2021, finding a prevalence of DVF (94.5%) using the same

Although we focus on the analysis of these 2 diagnostic methods by surveys, there are studies such as the one by Mowatt et al., where they related ergonomic habits and the frequency of DVF through a survey designed and validated by themselves. They evaluated 409 students and found that 63% had severe DVF syndrome. Interestingly, musculoskeletal complaints were included in the questionnaire, with neck pain (75.1%) being found most frequently as part of the DVF [10].

The difference in the characterization of DVF through self-reported clinical symptoms could be the explanation for the concordance levels. Hayes originally designed a survey for an office setting, and its objective was to assess severity rather than a diagnosis of DVF [6], was subsequently applied to different contexts such as a university environment [7]. On the other hand, the survey used by Seguí provides us with a more extensive characterization of the syndrome as well as a lower cut-off point to speak of a positive case[8]. Therefore, if one or the other survey is to be applied in presumptive diagnostic settings or frequency studies, we recommend the application of Seguí's CVS-Q survey.

The sample was considered representative for the university, therefore, we can conclude that, in this context, the prevalence of DVF was high and that it should be considered as a potential public health problem especially in young adults due to the increasing exposure to digital screens for academic, work or recreational reasons. In addition, a high prevalence of refractive disorders such as astigmatism was evident. Similar findings were obtained in the study conducted by Wangsang K. in Thailand where he found a significant association between astigmatism and a positive diagnosis of DVF ($p = 0.041$)[17]. DVF is also described in children, however, self-reporting methods would not be optimal and the characterization of DVF in this age group is different[18].

Limitations

The study has limitations, one of them was the different survey modality of the study participants. First, the survey was applied physically in printed formats; it was evident that there were problems understanding the instructions at the time of filling out the Seguí survey, so the virtual filling modality was changed through Google Forms. To address this limitation, a stratified analysis of agreement by survey modality was performed. Another limitation was the possible poor understanding of some symptoms such as the visualization of colored halos or the sensation of a foreign body. Likewise, the Hayes survey did not offer the same validation parameters as the Seguí survey, thus limiting further points of comparison between both methods.

CONCLUSION

In conclusion, the surveys by Hayes et al. and Seguí's CVS-Q, although they share the same objective of measuring the frequency of DVF and through the same self-report method, showed acceptable agreement for the detection of DVF in women and moderate in the other strata and at a global level, thus showing that they do not have the same approach when dictating a presumptive positive diagnosis of DVF. With these data, we recommend promoting optimal vision care among populations such as university students and encouraging DVF research to implement timely management. The diverse association with other health problems such as vision accommodation problems and constant headaches [19] make its detection a priority. Recommendations can be as simple as ergonomic practices to the use of special focusing lenses[20].

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