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Resiliencia en estudiantes universitarios, después del impacto del Huracán Otis en Acapulco, Guerrero

Resilience in university students after the impact of Hurricane Otis in Acapulco, Guerrero

Resiliência em estudantes universitários após o impacto do furacão Otis em Acapulco, Guerrero

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Resumen

El presente artículo tuvo como objetivo principal analizar las características socioeconómicas y de resiliencia en estudiantes de educación media superior y pregrado de la Universidad Autónoma de Guerrero (México). El diseño transversal del estudio se basó en un enfoque descriptivo-correlacional, donde se aplicó un cuestionario con dos secciones: la primera incluyó aspectos personales, socioeconómicos y de vulnerabilidad ante amenazas hidrometeorológicas, la segunda parte estuvo relacionada con la Escala de Resiliencia (RS-25) la cual alcanzó una consistencia interna de 0.887 (alfa de Cronbach). Quienes tienen sus viviendas ubicadas en áreas propensas a inundaciones y viven en casas de madera y lámina se asocia con la escolaridad máxima de bachillerato del padre y la madre. la afectación económica familiar y el daño desastroso de su vivienda, mientras que, vivir en zona no propensa a inundaciones, se asoció con: llegar a la escuela en 30 minutos o más; afectación económica familiar y daño desastroso de su vivienda. El 61.7 % (92/149) de las alumnas cursan la educación media superior, y el 69.4 % (102/147) son de pregrado, en este contexto, las mujeres mostraron una mayor resiliencia según el ítem 23: “Cuando estoy en una situación difícil, generalmente encuentro una salida” (OR = 2.072 [IC 95 % 1.058-4.059]). El análisis factorial abarcó seis dimensiones: autoeficacia, motivación intrínseca, fortaleza emocional, madurez emocional, pragmatismo y sentido de propósito, las cuales explican el 58.38 % de la varianza total; la idoneidad de la escala se determinó con la medida de KMO = 0.898. Es necesario que las autoridades educativas contribuyan al bienestar emocional del estudiantado tras haber experimentado los efectos del huracán Otis (2023).

Palabras clave: huracán, resiliencia, correlación, inundación, desastre.

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Abstract

The main aim of this article was to analyze the socioeconomic and resilience characteristics of high school and undergraduate students at the Autonomous University of Guerrero (Mexico). The cross-sectional design of the study was based on a descriptive-correlational approach, the second part referred to the Resilience Scale (RS-25), which reached an internal consistency of 0,887 (Cronbach´s alpha). Living in flood zones and in wooden or tin houses is associated with parent´s maximum education level being high school, family economic impact, and severe damage to their homes, while living in non-flood zones is associated with: getting to school in 30 minutes or more; family economic impact and disastrous damage to their homes. In this context, females are slightly more resilient to item 23 "when I am in a difficult situation, I usually find a way out" (OR = 2,072 [95 % CI 1,058-4,059]. The factor analysis covered six dimensions: self-efficacy, intrinsic motivation, emotional strength, emotional maturity, pragmatism, and sense of purpose, which explain 58,38 % of the total variance; the appropriateness of the scale was determined with the KMO measure = 0,898. It is essential that the educational authorities contribute to the emotional well-being of the student body, after having experienced the effects of hurricane Otis.

Keywords: hurricane, resilience, correlation, flood, disaster.

Resumo

O objetivo principal deste artigo foi analisar as características socioeconômicas e de resiliência de estudantes do ensino médio e de graduação da Universidade Autônoma de Guerrero (México). O delineamento transversal do estudo foi baseado em uma abordagem descritivo-correlacional, onde foi aplicado um questionário com duas seções: a primeira contemplou aspectos pessoais, socioeconômicos e de vulnerabilidade às ameaças hidrometeorológicas, a segunda parte foi relacionada à Escala de Resiliência (RS-25) que atingiu uma consistência interna de 0,887 (alfa de Cronbach). Aqueles que têm suas casas localizadas em áreas propensas a inundações e vivem em casas de madeira e chapas de metal estão associados a, no máximo, ensino médio completo para ambos os pais. o impacto econômico sobre a família e os danos desastrosos à sua casa, enquanto vivia em uma área não propensa a inundações, estava associado a: chegar à escola em 30 minutos ou mais; impacto econômico familiar e danos desastrosos à sua casa. 61,7% (92/149) das estudantes do sexo feminino estão no ensino médio e 69,4% (102/147) são estudantes de graduação.

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Nesse contexto, as mulheres demonstraram maior resiliência de acordo com o item 23: "Quando estou em uma situação difícil, costumo encontrar uma saída" (OR = 2,072 [IC 95% 1,058-4,059]). A análise fatorial abrangeu seis dimensões: autoeficácia, motivação intrínseca, força emocional, maturidade emocional, pragmatismo e senso de propósito, que explicaram 58,38% da variância total; A adequação da escala foi determinada com a medida de KMO = 0,898. É necessário que as autoridades educacionais contribuam para o bem-estar emocional dos alunos após terem vivenciado os efeitos do furacão Otis (2023).

Palavras-chave: furacão, resiliência, correlação, inundação, desastre.

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Introduction

Climate change and observed risks

Natural threats such as hurricanes, tropical storms, floods, heat waves, droughts, fires and extreme heat are some of the hydrometeorological phenomena that result from the alteration of atmospheric, hydrological or oceanographic processes, due to climate change, derived mainly from the emission of greenhouse gases, whose concentration in the atmosphere has increased since the beginning of the Industrial Revolution, however, since 1950, the planet has experienced a constant rise in its temperature, which leads to changes in the intensity of the trade winds, the formation of cyclones and anticyclones, and the alteration of the pattern of rainfall and droughts, with negative effects on terrestrial, cryospheric, coastal and marine ecosystems (Calvin, *et al* ., 2023; Castelo, *et al* ., 2024; Senapati, *et al* ., 2022) .

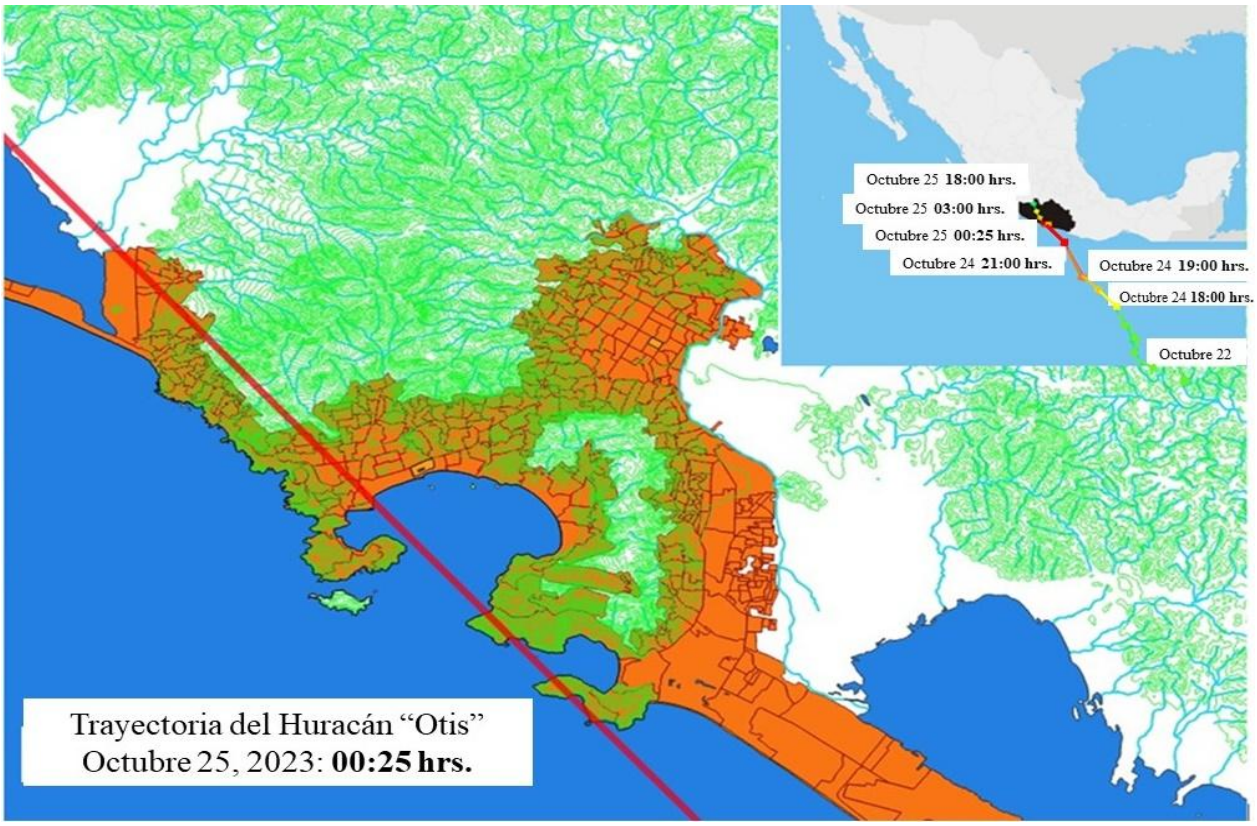
Hurricanes are rotating storms developed in the northern hemisphere formed over warm ocean waters and together with atmospheric conditions where convergent winds predominate that generate a low pressure zone on the surface, the change of wind with height, as well as the heat and humidity that rise, cool and form clouds that feed the storm, and can reach catastrophic effects (AMIS, 2024). However, in order to reduce the vulnerability of the population, ecosystems and productive sectors, policies have been established aimed at mitigating their effects, both nationally and internationally (IOC-UNESCO, 2024; General Law on Climate Change, 2023). In Mexico, especially the state of Guerrero, there are geographical characteristics, such as its latitude, relief and location on the coast of the Pacific Ocean, that make it highly vulnerable to climate change, particularly to hydrometeorological phenomena (INECC, 2019). The coasts of the Mexican Pacific Ocean are highly vulnerable

to the presence of hurricanes that have reached Category 5, such as Hurricane Patricia in 2015 and Hurricane Otis in 2023.

The knowledge acquired on the danger derived from threats from previous hydrometeorological phenomena (CENAPRED, 2019) has contributed to improving risk management through microzoning, warning of the greater or lesser vulnerability of the population to the effects derived from winds and heavy rains, coupled with the interaction with geological and human factors.

The information obtained from hurricane disasters that occurred in the urban area of Acapulco has served to identify the level of risk in two main areas of Acapulco Bay: the continental area, with a high mitigable risk, and the middle region, with no mitigable risk. Hurricane Otis, which occurred on October 25, 2023, had a changing trajectory, described in Figure 1, with catastrophic effects in areas with high population density in the state of Guerrero: 22% (779.566 / 3.540.685) and 2,1% (73.056 / 3.540.685) of the state population live in the municipalities of Acapulco and Coyuca de Benítez, respectively (INEGI [National Institute of Statistics and Geography], 2021). However, until before Hurricane Otis (2023), there was a very low probability of the impact of a phenomenon with a high intensity on the *Saffir-Simpson scale*, exceeding international models, because in less than 12 hours it went from a tropical storm (with winds of 64 km/h) to a Category 5 hurricane (with sustained winds of 270 km/h and gusts of 330 km/h [CNA, 2024]).

Figure 1. Acapulco Bay. Trajectory of Hurricane Otis (2023) and its evolution from a tropical depression to a Category 5 hurricane.



Source: Prepared by the authors using data from CONAGUA (CNA)

Resilience and its measurement

After having experienced the impact and catastrophic effects of Hurricane Otis, particularly on the student population, where more than 300 schools, at all educational levels, were partially or totally affected (Government of the State of Guerrero, 2023). Consequently, resilience or recovery in the face of overwhelming adversity, differences have been found in terms of risk and protection factors, even when exposure is similar (Lai, *et al* ., 2015). These hydrometeorological phenomena not only affect ecosystems, but also the adaptation and recovery capacity of exposed populations, which highlights the importance of studying resilience in vulnerable contexts.

The concept of resilience comes from the Latin *resilio*, which means "to bounce back", "to jump back" or "to return", and from the field of physics, it refers to the ability of a material to return to its original form after having been deformed. Resilience is the coping capacity of a resilient individual, where he or she recovers and adapts to a changing situation,

is affected by situations with a high level of stress, originating from new risks and challenges in the context of physical and emotional health, derived from global social, political and economic changes, such as migration, economic recession, diseases or natural disasters.

Resilience is a personality characteristic that regulates the negative effects of stress or adversity and is related to maintaining a positive adaptation to conditions that can threaten life, where people face traumatic contexts or situations that are unavoidable, but they can emerge stronger from that stressful situation (Gómez-Romero, *et al* ., 2020; Mert, *et al* ., 2021; Warnecke & Lewine, 2019).

In the field of psychology, the term describes the ability of people to successfully adapt to or recover from negative life events and is referred to as the dynamic and interpersonal process of adaptation to various difficult, challenging, stressful or adverse life experiences, which is viewed from two perspectives: the first is based on exposure to adverse or serious situations and the second, on achieving positive adaptation through fighting, recovering from and overcoming negative or traumatic obstacles or circumstances such as wars, deportations, epidemics or catastrophes arising from natural threats (American Psychological Association, 2023; Garmezy, 1991; Lind, *et al* ., 2018).

From a broader point of view, resilience as a construct is not only limited to the individual quality of a person, but to the process with unique characteristics of each person that negatively or positively influences resilient processes such as motivation, autonomy, self-acceptance, competence, creativity and empathy. In the broadest sense of resilience, people who, collectively, experience an adverse situation set up a network made up of multiple elements that support the individual such as family, friends, school and the community, with the aim of achieving behavioral change focused on enhancing the resilience process by promoting communal coping to find solutions to collective problems (Fuentes Aguilar, *et al* ., 2021).

Resilience thinking is based on the understanding that ecological and social systems are widely integrated, making them considerably complex systems in the fight against climate change that has led to an increase in meteorological disturbances globally (Bahadur, *et al* ., 2010) . In this context, the coastal zone of Mexico, especially areas with high population density, are potentially vulnerable to the impact of tropical cyclones, while in 2023, 42 tropical cyclones occurred, of which 12 were strong, with categories between one or two on the *Saffir-Simpson scale*, and five were intense with categories between three and five on the same scale, of the latter three developed in the Atlantic Ocean and two in the Pacific Ocean

(Comisión Nacional del Agua [CNA], 2024; National Hurricane Center and Central Pacific Hurricane Center [NHC-CPHC], 2024) .

There are different scales to measure resilience, which are adapted to a wide variety of contexts, however, some psychometric instruments such as the Resilience Scale (RS-25) is made up of 25 items or statements, which has shown good reliability and validity in various environments (Rodríguez Rodríguez & Urrea Monclús, 2021; Wagnild & Young, 1993). The general objective of this study was to analyze the socioeconomic and resilience characteristics of high school and undergraduate students at the Autonomous University of Guerrero in Acapulco. The specific objectives were to determine the psychometric properties of the Resilience Scale (RS-25), used in students aged 15 to 26 years, and to evaluate the resilience shown by students after the passage of Hurricane Otis (2023).

Material and Methods

Participants and process

In this cross-sectional, quantitative and analytical study, data obtained through a self-administered, voluntary and anonymous survey, directed to Acapulco students at the upper secondary and undergraduate levels of education at UAGro, were analyzed. The survey was applied at the beginning of February (at the beginning of the second semester of the 2023-24 school year), after the cleaning and rehabilitation of the school physical spaces, as well as the gradual resumption of public services (Figueroa, 2024). For the selection of one or two academic groups for each of the schools included in the research, the location in different geographical areas within the urban and suburban areas of Acapulco was considered, the latter area has the characteristic of being outside the city and lacking some of the services that large cities have.

Convenience selection considered the accessibility of the student population, the level of exposure to the effects of the hurricane, the location of the schools or faculties, and the level of damage to the school infrastructure, given that rehabilitation was decisive for the return to in-person classes (Avilez Rodríguez, 2024). In this context, the Faculty of Marine Ecology, which is located near the city's coastline, and the Faculty of Environmental Sciences, located in the suburban area and characterized by its high-risk flooding location (Rodríguez Herrera, *et al* ., 2012), were included. While the Faculty of Nursing No. 2 and High School Nº. 2 are located in the urban area of Acapulco. The study population included

149 (50,3%) high school students and 147 (49,7%) undergraduate students. Table 1 describes the general characteristics of the student population participating in this research.

Table 1. General characteristics of the study population (n=296)

Level of education		Shift	Number of groups	n	%	M (DE)	Range
Upper secondary education (n = 149)	School Nº. 2 School Nº. 2 Nursing Technician	Morning Evening Morning	one one one	50 50 49	16,9 16,9 16,6		
Sex	Men Women He did not indicate his affiliation			57 91 1	38,3 61 0,7		
Age						16,56 (1,2)	15-21
Undergraduate (n = 147)	Faculty of Marine Ecology Faculty of Environmental Sciences Faculty of Nursing Nº. 2		two one two	63 16 68	21,3 5,4 23		
Sex	Men Women He did not indicate his affiliation			44 102 1	29,9 69,4 0,7		
Age						21,04 (2,1)	18-26
Total				296			

M=Mean SD=Standard deviation

Source: Own elaboration

Instruments and materials

The questionnaire design included questions related to personal, family and school aspects, as well as damage to public services in their immediate environment and the Resilience Scale, designed to assess personality characteristics in adolescents and adults, ages similar to the population studied in this research. In addition, it included an additive Likert-type scale with values ranging from one (too much disagreement) to seven (too much agreement). The score varies between the minimum value of 25 and the maximum value of

175 points, the latter value being associated with high resilience, understood as the positive personality trait that allows subjects to adapt to adversity and reduce stress levels.

To determine the psychometric properties of the questionnaire, the validation parameters used in the original proposal were considered, in which it compares current life with past life and with the lives of others (Wagnild & Young, 1993) . The initial validation of the questionnaire and the RS-25 was reviewed by a round of experts (Álvarez-Ríos, *et al* ., 2018): an Organizational Psychologist, two specialists in Regional Development and an Epidemiologist, who were responsible for providing an assessment of the quantitative and qualitative components of the instrument. From the pilot test, applied to 12 students with similar characteristics to the study population, it served to standardize the questionnaire, readapt some questions, as well as the initial reliability of the RS-25 items, which was 0,817 in this sample. Likewise, three questions were eliminated from the instrument due to the imprecision of the concepts: disturbing phenomena, vulnerability and danger.

Statistical processing

The data were analyzed using the statistical package SPSS Version 25 (*Statistical Package for the Social Sciences* [IBM Corp., 2017]). The descriptive and inferential analysis served to explore the correlation between variables using the Chi-square statistical tests (χ^2), reliability (p), as well as the odds ratio (OR) and their confidence intervals (95% CI). The factor analysis of the RS-25 was performed with the KMO tests and the Bartlett test of sphericity, the factor loadings (sum of variances) were determined using the Varimax rotation method, while the reliability was calculated with the Cronbach alpha coefficient (Pizarro Romero and Martínez Mora, 2020).

Results

Descriptive statistics

The descriptive analysis of the population studied shows the socioeconomic characteristics of high school and undergraduate students in Acapulco Guerrero (Table 2). 89,7% (260/296) of the students said they were originally from Acapulco; 2% (6/296) from the municipality of Coyuca de Benítez, the rest are from other municipalities or states; while 8,1% (24/260) live alone. Regarding the risk of flooding in their home, 40,9% (121/296) indicated this predisposition during the rains, likewise, those who reported having their home

less than 100 meters from a water stream: 28,4% (84/296) near a river and 27,7% (82/296) near a stream or ravine.

On the other hand, the damage caused to urban infrastructure that is built in river beds or areas close to the coastline also reflects what happened in its immediate surroundings and in the city. Table 2 shows the contrast between the population of students who reported that their home was in areas prone to flooding, compared to those who live in areas not prone to flooding. In the bivariate analysis, it was found that seven factors were significantly associated with the construction material (wood and sheet metal) with which their homes were made: areas not prone to flooding (30 minutes or more to get to school, impact on the family economy by the hurricane and disastrous damage to their home), and areas prone to flooding (maximum schooling of upper secondary education of the father , maximum schooling of upper secondary education of the mother, impact on the family economy by the hurricane and disastrous damage to their home), the values were statistically significant ($p \leq 0,05$).

Table 2. Bivariate analysis of factors associated with the impact of Hurricane Otis (2023)

(n = 296)

Area of housing location	Variable		House made of wood and sheet metal Ω		Concrete house Ω		χ^2	gl *	p-value
			n	%	n	%			
Prone to flooding	Housing close to a river (distance <100 m)	Yeah	24	*51,1*	23	*48,9*	0,013	1	0,910
		No	35	*50*	35	*50*			
Not prone to flooding	Housing close to a river (distance <100 m)	Yeah	11	*34,4*	21	*65,6*	0,258	1	0,611
		No	42	*29,8*	99	*70,3*			
Prone to flooding	House close to a ravine (<100 m)	Yeah	22	*62,9*	13	*37,1*	3,290	1	0,070
		No	37	*44,6*	46	*55,4*			
Not prone to flooding	House close to a ravine (<100 m)	Yeah	14	*34,1*	27	*65,9*	0,391	1	0,532
		No	38	*29*	93	*71*			
Prone to flooding	Time to get to school (30 min)	≥	47	*55,3*	39	*44,7*	3,407	1	0,065
		<	12	*36,4*	21	*63,6*			
Not prone to flooding	Time to get to school (30 min)	≥	40	*37,7*	66	*62,3*	6,779	1	0,009
		<	13	*19,1*	55	*80,9*			
Prone to flooding	Father's education (b: upper secondary education/p: postgraduate)	b	52	*61,9*	32	*38,1*	15,532	1	0,000
		p	6	*20*	24	*80*			
Not prone to flooding	Father's education (b: upper secondary education/p: postgraduate)	b	38	*33,6*	75	*66,4*	3,337	1	0,068
		p	10	*19,6*	41	*80,4*			
Prone to flooding	Mother's education (b: upper secondary education / p: postgraduate)	b	51	*61,4*	32	*38,6*	14,664	1	0,000
		p	8	*22,9*	27	*77,1*			
Not prone to flooding	Mother's education (b: upper secondary education / p: postgraduate)	b	38	*33*	77	*67*	0,809	1	0,368
		p	15	*26,3*	42	*73,7*			
Prone to flooding	The hurricane affected the family economy	Yeah	46	*59,7*	31	*40,3*	9,010	1	0,003
		No	13	*31*	29	*69*			
Not prone to flooding	The hurricane affected the family economy	Yeah	28	*41,2*	40	*58,8*	6,588	1	0,010
		No	24	*22,9*	81	*77,1*			
Prone to flooding	Damage to your home	d	21	*84*	4	*16*	14,668	1	0,000
		p	38	*40,9*	55	*59,1*			

Not prone to flooding	(d: disastrous / p: little) Damage to your home (d: disastrous / p: little)	d	15	*57,7*	11	*43,3*	10,541	1	0,001
		p	38	*25,9*	109	*74,1*			

χ^2 = Chi square * degrees of freedom p-value = significance (≤ 0,05)

Ω housing construction material

Source: Own elaboration

In the bivariate analysis, described in Table 3, where the strength of association and 95% confidence intervals are recorded, it was found that having had economic and connectivity problems was significantly associated with having problems continuing to study, as well as: having your home in a flood zone, not having your own home, as well as having suffered serious damage to your home due to the effects of the hurricane.

Table 3. Bivariate analysis of factors associated with problems continuing to study, in the context of the effects of Hurricane Otis (2023)

Variable		Problems to continue studying		OR *	95% CI **
		n	%		
Economic and connectivity problems	Yeah	58 / 70	82,9	2,148	1,080-4,273
	No	144 / 208	69,2		
Housing located in an area susceptible to flooding	Yeah	39 / 117	33,3	2,219	1,289-3,819
	No	32 / 174	18,4		
Have you received any training on what to do in case of hurricanes?	No	65 / 245	26,5	1,866	0,744-4,677
	Yeah	6 / 37	16,2		
Your home is your own	No	33 / 88	37,5	2,526	1,446-4,414
	Yeah	38 / 198	19,2		
Father of a family without studies	Yeah	1 / 8	12,5	0,463	0,056-3,832
	No	63 / 267	23,6		
Mother of a family without studies	Yeah	2 / 5	40,0	2,038	0,334-12,447
	No	70 / 284	24,6		
Serious damage to your home	Yeah	20 / 52	38,5	2,236	1,182-4,230
	No	52 / 238	21,8		

* Odds ratio ** 95% confidence intervals

Source: Own elaboration

Table 4 presents the descriptive statistics of the items, where the mean, standard deviation, correlations and reliability were evaluated, where the different items are evaluated

within the same scale, so that the values of Cronbach's alpha, between 0,879 and 0,902, guarantee the coherence of the measurement.

Table 4. Descriptive statistics, correlation of variables and reliability of the items of the Resilience Scale (RS-25) in high school and undergraduate students (n = 296).

	n	Average	Standard deviation	Correlations / Reliability	
				Corrected item-total	Cronbach's alpha*
Item 1. When I plan something, I do it.	294	5	1,688	0,553	0,881
Item 2. I usually manage one way or another.	293	5,51	1,567	0,511	0,882
Item 3. I depend more on myself than on other people.	291	4,99	1,885	0,48	0,883
Item 4. It is important for me to stay interested in things.	292	5,36	1,653	0,527	0,882
Item 5. I can be alone if I have to.	294	5,49	1,925	0,49	0,882
Item 6. I feel proud of having achieved things in my life	293	5,83	1,643	0,625	0,88
Item 7. I usually see things in the long term.	294	5,01	1,771	0,44	0,883
Item 8. I feel good about myself	292	5,26	1,918	0,617	0,879
Item 9. I feel like I can handle several things at the same time.	290	4,49	1,842	0,597	0,88
Item 10. I am determined.	294	4,79	1,864	0,635	0,879
Item 11. I rarely wonder what the purpose of everything is.	294	4,52	1,933	0,372	0,885
Item 12. I take things one by one.	293	4,69	1,606	0,481	0,883
Item 13. I can face difficulties because I have experienced them before.	294	5,21	1,679	0,571	0,881
Item 14. I have self-discipline.	292	4,84	1,697	0,613	0,88
Item 15. I stay interested in things.	291	4,98	1,697	0,606	0,88
Item 16. I usually find something to laugh about.	287	5,84	3,349	0,238	0,896
Item 17. Believing in myself allows me to get through difficult times.	293	5,43	1,706	0,633	0,88
Item 18. In an emergency I am a person who can be trusted .	291	5,66	1.714	0,519	0,882
Item 19. I can usually see a situation in several ways.	289	5,36	1,571	0,634	0,88

Item 20. Sometimes I force myself to do coke, even if I don't want to.	289	4,97	1,887	0,2	0,889
Item 21. My life has meaning.	290	5,61	4	0,24	0,902
Item 22. I don't regret things I can't do anything about.	290	4,52	1,903	0,487	0,882
Item 23. When I'm in a difficult situation, I usually find a way out .	291	5,27	1,621	0,634	0,88
Item 24. I have enough energy to do what I need to do.	292	5,18	1,687	0,602	0,88
Item 25. I accept that there are people who do not like me.	293	5,91	1,735	0,43	0,884

Source: Own elaboration

Exploratory factor analysis

To check the suitability of the data obtained using the Resilience Scale for factor analysis, the KMO (*Kaiser-Meyer-Olkin) adequacy test and the Bartlett* sphericity test were used, and then the factor structure analysis was performed on the data set.

By removing items 16 and 22, which had a low correlation (0.221 and 0.398 respectively), the KMO value remained constant (0.89), but the accumulated percentage of variance increased (Table 5), which explains a better model of the underlying structure of the data, however, when considering the total number of items, it provides a more accurate assessment of resilience.

Table 5. Measure of data suitability for factor analysis

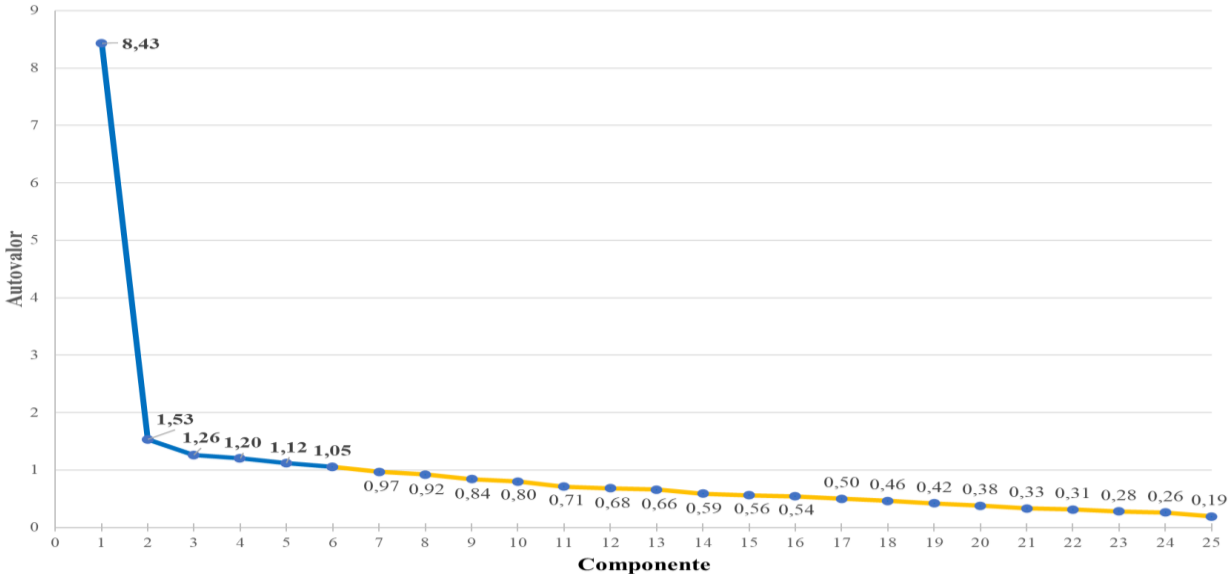
Items: 1-25	KMO (*Kaiser-Meyer-Olkin*) measure		0,898
	Bartlett 's test of sphericity	Approximate Chi-square	2.423,367
		Degrees of freedom (df)	300
		Level of significance	0,000
	Cumulative percentage of variance		58,383
Items:1-15 17-21 23-25 *Item 16 and item 22 were excluded	KMO (*Kaiser-Meyer-Olkin*) measure		0,898
	Bartlett 's test of sphericity	Approximate Chi-square	2.340,575
		Degrees of freedom (df)	253
		Level of significance	0,000
	Cumulative percentage of variance		61,606

Source: Own elaboration

In the study, the RS-25 covered six dimensions or areas: self-efficacy (items 14, 15, 8, 10, 23, 9, 24, 17), intrinsic motivation (items 1, 2, 4, 6), emotional strength (items 13, 3, 5, 20), emotional maturity (items 18, 25, 19, 16), pragmatism (items 11, 12, 7, 22), and sense of purpose (item 21). In the factor analysis (principal component analysis), the six dimensions described in Table 6 account for 58,38% of the total variance explained. Likewise, the sedimentation graph (Fig. 2) shows the eigenvalues on the y-axis and the number of factors or components on the x-axis. Eigenvalues greater than 1 indicate the number of factors retained, where the cumulative percentage is 58,38%.

The Chi-square test of independence revealed a statistically significant association between men and women for item 23 (self-efficacy) and item 6 (intrinsic motivation). Using the Chi-square test of independence, they showed statistical significance between men and women, while the dimensions "emotional strength", "emotional maturity", "pragmatism" and "sense of purpose" did not show significant differences in relation to sex (Table 6). On the other hand, to explore the variable sex with respect to resilience, 2 X 2 tables were used to determine the risk (OR). The responses of the items were recoded into low resilience (1, 2, 3 = 1) and high resilience (5, 6, 7 = 2), and considering that the intermediate value suggests a neutral or moderate position in the individual's resilience, the value 4 was not included in the analysis.

Figure 2. Sedimentation plot of the items of the Resilience Scale (RS-25)



Source: Own elaboration

Unlike the values obtained with the Chi-square test, in the bivariate analysis it was found that item 23 “when I am in a difficult situation, I usually find a way out”, men showed less resilience in relation to women (OR = 2,072 [95% CI 1,058-4,059]), while item 6 “I feel proud of having achieved things in my life” showed no association between the sex variable and the resilience variable (OR = 1,061 [95% CI 0,482-2,336]), same effect for item 13 (OR = 0,726 [95% CI 0,356-1,479]) ; item 18 (OR = 1,861 [95% CI 0,915-3,785]); item 12 (OR = 0,956 [95% CI 0,517-1,767]), and finally item 21 (OR = 1,306 [95% CI 0,678-2,517]).

Table 6. Dimensions of the RS-25 Resilience Scale and their correlation by sex

Dimension	Component	< resilience > resilience							χ^{2} †	gl ††	*p*-value
		1	2	3	4	5	6	7			
Self-efficacy Item 23	Man	4	5	13	9	17	18	34	17,021	6	0,009 *
	Women	3	9	8	39	29	50	51			
Intrinsic motivation Item 6	Man	3	2	6	5	17	14	52	12,620	6	0,049 *
	Women	9	6	4	19	15	41	98			
Emotional strength Item 13	Man	3	5	5	14	13	24	36	6,487	6	0,371
	Women	10	6	14	38	30	47	47			
Emotional maturity Item 18	Man	7	3	7	8	19	19	36	8,820	6	0,184
	Women	8	5	6	15	22	38	96			
Pragmatism Item 12	Man	7	3	11	22	14	24	18	10,962	6	0,090
	Women	7	13	22	41	49	41	19			
Sense of purpose Item 21	Man	8	4	6	12	13	24	30	7,253	6	0,403
	Women	10	7	12	20	21	36	84			

† χ^{2} = Chi square †† degrees of freedom * *p* = significance (≤ 0,05)

Source: Own elaboration

Discussion

This cross-sectional study analyzed the effects of Hurricane Otis on high school and undergraduate students in the urban and suburban areas of Acapulco, considering their socioeconomic, family, educational, and personal environment. The questionnaire applied revealed economic impacts, vulnerability of housing to flooding, and damage to school facilities. As a result, nearly 10.000 university students restarted their classes in virtual mode during the 2024-25 school year (Avilez Rodríguez, 2024).

In line with the literature, the increase in housing in areas close to river and stream beds, as well as the limited knowledge about the location of temporary shelters (around 30%), is similar to that observed in other cities; however, knowledge about evacuation routes in the event of a hurricane or flood is lower, compared to other coastal states in Mexico (Camacho Sanabria, *et al* ., 2019; Rodríguez Esteves, 2017). The significance found among those who live in a non-floodable area and take 30 minutes or more to get to school, compared to those who live less than 30 minutes from the school. This could be explained by the location of some schools in areas at risk of flooding (Rodríguez Herrera, *et al* ., 2012).

Living in a flood zone and inhabiting a house made of wood and sheet metal is associated with the father's education level, which varies from no studies to high school level. In contrast, those who live in non-flood zones tend to live in concrete houses and have undergraduate or graduate studies, a situation similar to that of mothers. This socioeconomic context is related to current peripheral settlements, which may be undergoing an urbanization process (Hernández & Vieyra, 2010). Likewise, among the widespread effects of the hurricane, regardless of the area or the construction material of their homes, is the impact on the family economy and damage to their homes (Kanno Youngs & Rodríguez Mega, 2023).

In terms of resilience, the catastrophic experience of Hurricane Otis highlighted the coping capacity of students, particularly in the dimensions of self-efficacy and intrinsic motivation, according to the results obtained through the Resilience Scale (RS-25) (CNA, 2024). In this research, the RS-25 used as a measure of internal resources and positive contribution to emotional recovery, showed a reliability of 0.89, a characteristic that allows a better understanding of resistance to stress and success in adapting to new living conditions (Heilemann *et al* ., 2003; Wagnild & Young, 1993). In this context, and considering the six dimensions that explain almost 60% of the variance of the components, item 23: “when I am in a difficult situation, I usually find a way out”, registered in the *self-efficacy dimension* , had a significant difference in relation to sex, where women showed greater resilience than

men, results similar to the study carried out in a student population between 15 and 17 years old (Bucheli & Martínez, 2022), likewise, women show positive mental health (Gínez-Silva *et al* ., 2019; González-Arratia López Fuentes & Valdez Medina, 2015) in the face of stressors such as migration (Sajquim de Torres & Lusk, 2018), traditional attitudes towards gender roles (Goksel-Oflas & Yüksel-Şahin, 2019) , gender violence (Lazo Ancajima, 2021), COVID-19 pandemic (Reyes-Díaz *et al* ., 2023) , situations that can be addressed by the psychopedagogical departments of schools as well as through collaboration between peers (Cockroft et al ., 2023).

Unlike item 23 (self-efficacy) and item 6 (intrinsic motivation), which showed a significant association between the sex variable and the resilience variable (values from 1 to 7), items 13, 18, 12 and 21 showed no association in the analysis with the chi-square test ($p > 0,05$), which means that, in the student population studied, there is no evidence to indicate that women or men are emotionally stronger, however, differences may manifest over time (WHO, 2014), so it is necessary to carry out additional longitudinal measurements, at least three, to observe the evolution of resilience in students . Likewise, it is necessary to analyze post-traumatic experiences and variations in the perception of danger or fear, in order to identify underlying factors according to sex (First *et al* ., 2021). The main limitation of the study lies in its cross-sectional design, which restricts causal analysis. Therefore, systematic measurements at at least three time points are required to assess the evolution of resilience according to sex (Lai *et al* ., 2015).

Conclusions

The coastal population faces increasing vulnerability due to the intensification of natural phenomena, such as Hurricane Otis, which combines intense rains, high waves, storm surges, landslides and floods, with a high destructive potential for ecosystems and human settlements. Problems for further study were identified as being associated with housing vulnerability, economic problems and connectivity.

Regarding psychometric evaluation, the Resilience Scale (RS-25) showed adequate validity and reliability properties (Cronbach's alpha = 0,887) (Rua & Andreu, 2011; Wagnild & Young, 1993). This makes it a useful tool for studies that are carried out in similar contexts and populations. Exploratory factor analysis, based on the KMO and Bartlett's sphericity tests, confirmed the suitability of the scale. However, items 16 and 20 showed a low

correlation, suggesting the need for further research to explore how they are interpreted and adapt the scale to the specific context of the population studied.

Resilience analysis using the chi-square test revealed that women were more resilient than men, considering item 23 “when I am in a difficult situation, I usually find a way out, and item 6 “I feel proud of having achieved things in my life”, a situation that indicates that women demonstrated greater resilience, despite the gender vulnerability to which they are subject (Goksel-Oflas & Yüksel-Şahin, 2019). However, in situations of alteration of the social and economic fabric derived from emergencies or catastrophes, traditional roles between women and men can change and, consequently, people assume responsibilities that reduce the pre-existing gender gap.

The results of this research underline the need for educational authorities and peer support groups to strengthen attention to the emotional health of students, given that the magnitude of the disaster has reduced the observed differences in resilience. These findings coincide with those reported by Gómez-Romero *et al* ., (2020) and Warnecke & Lewine (2019), who highlight the greater female resilience in the face of socioeconomic adversities.

Future lines of research

In order to analyze the trajectory of resilience over a two-year period following the return to in-person classes after the effects of Hurricane Otis (2023), it is important to consider measuring three additional moments at the beginning of each semester, starting with the August 2024 - July 2025 school year. To avoid educational level bias, the students will be from the same schools that participated in this study, so that academic and social experiences are similar. Subsequent studies need to analyze post-disaster resilience in other sectors of the population in order to mitigate the effects of catastrophic events.

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