Assessment of Stress, Attention and Memory in High School Students in Latacunga, Ecuador: A cross-sectional survey

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Abstract*—Stress is the side effect of development. Nowadays school going children also had stress and it's after effects. So this research was carried out in order to evaluate indicators of stress level (stress test), attention (Toulouse-Pièron test), immediate memory (word list test) and working memory (reverse order digit test), to a group of 40 students of the school whose age was between 15 and 17 year. Survey done on first of April in the International Baccalaureate level of the Latacunga city, Cotopaxi province, Republic of Ecuador. The perceptual and attention testing Toluuse-Pièron for additions and omissions plus errors did not throw significant differences between gender; but they behaved over 20 % of the hits, which showed a lack of deep concentration and attention over time. The stress test showed that females were more stressed in relation to males; however, for the word test and the reverse-order digits, no significant differences between the genders were found. A nonlinear (polynomial) relationship was found between the stress of the students and the memory. So it can be concluded that females were significantly more stressed than males whereas regarding memory there was no significant difference in both the sexes. It was also revealed that there was no linear relation between stress and memory.*

Keywords: Stress, Attention, Memory, Concentration.

I. INTRODUCTION

Stress is one of the most common problems afflicting the current population; its presence alters numerous physiological processes and normal behavioral patterns of the individual. In humans and experimental models in non-human rodents and primates, stress has been shown to affect learning and memory, alter normal sleep patterns, contribute to the etiology and exacerbation of diseases and relate to the onset and maintenance of addictive behaviors.[1]

The academic stress[2,3] in the university context is considered as the impact that the student can be produce by its organizational environment. In this case of the university, it is considered that the academic stress is generated from the demands of the academic environment, without having to intervene in a significant way external aspects to the academic life.

It is reasonable to suppose that many of the demands, conflicts, activities and events involved in the academic life provoke stress, negatively affecting the health, well-being and in the academic performance of the students. In a study,[4] author himself defines four groups of relevant variables that explain the academic stress: the academic stressors, the student's experience, the effects and consequences of academic stress and the modulating or moderator variables.[4]

Related to academic stress, when the student estimates that the requirements of a situation exceed their resources and capacities, they begins to feel stressed.[5] If the lag is highly charged, their thoughts will be unhopeful and negative emotions, consequently the effort and productivity will decrease and is called distress.[6,7]

If the student is confident in responding effectively, the probability of reaching their goal will increase, thoughts and emotions will be more positive throughout the coping process, experiencing what is called eustress or positive stress.[5]

The aim of this study was to determine the influence of stress through various tests in a group of high school students in Latacunga city, Cotopaxi province, Ecuador.

II. METHODOLOGY

This cross-sectional survey was carried out in the international baccalaureate level school on April First in Latacunga city, of the Cotopaxi province in the Republic of Ecuador in the year 2016. For this study, 40 students were selected randomly from the first and second year of baccalaureate, whose age ranged between 15-17 years. From 40 selected students, 24 were of the female sex and 16 of the male sex. With the 40 students selected, the process to be developed was socialized in order to make known the purpose of the investigation, in such a way that they have clarity and to obtain the respective authorization.

In the sample of the 40 students the following measurements and their corresponding instruments were carried out:

A. Stress level. Stress test.

B. Level of care. Toulouse-Pièron test.

C. Immediate memory. Word list test.

D. Working memory. Reverse digits test.

Stress level through "Stress test": The stress test was carried out on the basis of a questionnaire of perceived stress, through a Likert type of scale, with three questions, modified of the proposal by Levenstein et al., 2000.[8]

The 10 questions that integrated the questionnaire cover situations in the student's academic life that can cause stress. The responses of the participants indicate the level of stress they experience in the same using a response scale of 40 points, as a basis, the range of 10-0 points indicated that the person has no chronic stress, of 11-24 indicated an intermediate stress that is still controllable, 25-40 it was considered acute stress, allowing to verify with the results of the memory test, if the stress helps the intellectual development as well as with the quantitative results of the subjects of greater difficulty where it is necessary a greater concentration.

Level of care though "Toulouse Test-Pièron": The Toulouse–Pièron test, was used to know the level of concentration, for which the relationship of stress and the academic performance of the students was verified. This test tries that at the top of the whole table presented are three boxes with different figures. To put it into practice, each student was asked to find the similar figures and underline them within 10 minutes. This test had the valuation of 100 successes being 80 the top of hits.

The present test was applied after the stress test to determine the influence of stress on the concentration.[9] The method to qualify this test is as follows.

Quantitative valuation:

1) The number of underlined squares must be greater than 100.

2) The number of failures (omissions + errors) must not exceed 10 % of the successes.

3) Errors must not exceed two-fifths of omissions.

Qualitative assessment:

1) Failure of point 1. The number of successes below the indicated shows usually a psychic inhibition. A high score of successes with many errors and omissions (hasty execution) may indicate a state of generalized anxiety.

2) Failure of point 2 (Errors + omissions above 10% of the successes), we can consider it a failure of concentration, which will be deep in the case of exceeding 20 %.

3) Failure of point 3 (proportion of errors or omissions), we can interpret it as lack of intelligence, with other techniques of intelligence.

The Toluose–Pièron test was applied for five non-consecutive days. Successes (A), omissions and errors (O + E) for each gender of the students surveyed were determined. The subscripts indicate the results obtained from the first day to the fifth.

Immediate memory though "Word List Test": To measure the memory, two of the 11 subtests comprising the Wechsler memory scale. The two subsets applied and that are of optional application were the word test, which evaluates the immediate memory and the test of digits of reverse order, whose purpose is to evaluate the working memory. [10, 11]

Test list of words: In the experiment the immediate memory was evaluated through the repetition of a list of words. This initial test was used to evaluate the memory in each student. The same that was evaluated on 24 points based on 6 points as normal memory level, the data were recorded considering the following ranges of scores:

1) 0-6 low level

2) 7-12 memory next to achieve a good memory.

3) 13-18 reaches the right memory level.

4) 19-24 reaches the maximum memory level

The instructions for carrying out the "list of words" Test are presented below.[12]

1. The following instruction is given to the individual object of study: A list of words will be read below; the students must listen carefully so that when you finish say all those you remember, and do not need to repeat them in the same order.
2. The individual is presented with a list of 15 words (in this case are used those included in the Weschler Memory Scale) which are unrelated words. The presentation of the words is at the rate of 1 word per second.

3. The normal rating is from 6 points. Be careful when interpreting the results, as some of the participants in the experiment can get nervous and obtain a slightly lower yield.

The usefulness of the evaluation of the immediate memory is to know to what extent the stroke of the memory is lost in very short term (immediately after being presented the stimulus). It is carried out through repetition tasks immediately after the stimuli are presented. It does not require short term storage or manipulation of the information, as is the case with the working memory. This is a passive process on the part of the subject, related to the sensory and motor areas necessary to register and reproduce the information presented. It would be related to the area of the brain associated with language.[12]

Working memory through "Digit test in reverse order": The simplest tests of verbal working memory are the digits in reverse order, which measures the working memory spatial see. It consists of knowing how many bits of information are able to serve a person and repeat them in reverse order. Performance is affected by attention problems. Digits are arranged in 7 pairs of number sequences, 1 through 9. The procedure for applying this test is as follows.[12]

1. Instructions: Students are informed that they will be told a few numbers, they listen carefully and when they are finished, they must be repeated by the students but upside down. The numbers are presented in a normal tone of voice, at a speed of one per second, avoiding the grouping of the numbers in pairs or in sequences that can serve as a help for the repetition. The presentation starts with the sequence of two numbers and continues until the individual fails.
2. A person with an average intellectual level can repeat 4 digits without difficulty (1 less than in direct order).

Results of this test were evaluated as follows on 9 points:-

1. 2-3 low retention level
2. 4-5 reaches proper retention level
3. 6-7 exceeds the retention level
4. 8-9 the retention level is high and the student are considered students who memorize.

Simple linear regression and nonlinear: With the results of the stress test and word (memory) applied to the 40 students selected, a simple linear regression analysis was performed, assuming the stress test as an independent variable (x) and the results of the test of words as dependent variable (y). First to know if the data were adjusted to a simple linear regression was performed the analysis of variance of the linear regression simple and determined the value of the significance of the variable returns (stress).

As the variable value returned in the simple linear regression model was not significant or there is no linear relationship, we proceeded to search within the models of nonlinear regressions. It not to be significant the significance´s value of the independent variable, we proceeded to search within the nonlinear regressions which best adjusted. The degree six polynomial models was the best fit, for the nonlinear regression polynomial.

The coefficient of determination (R^2), the standard error (SE) and the graph of dispersion of the residues versus the predicted values, the equation, the parameters that integrate it and its coefficients were determined.

Statistical data processing: Since the data did not meet the assumption of normalcy, the Wilcoxon-Mann-Whitney U test was applied, [13] to determine the average range of the samples relationships for each of the sexes among the 40 students surveyed, the existence of significant differences between female (F) and male (M) students, in the stress tests, test list of words, the reverse-order digit test, and the Toulouse-Pièron test for successes and omissions more errors was calculated. The probability (p) at 0.005 percent that determines the existence of significant differences between genders for each of the tests used. Infostat[14] and CurveExpert[15] software's was applied.

III. RESULTS

In this study various tests were applied on 40 randomly selected students and results were as follows:-

Toulouse-Pièron test: The results of perceptual and attention test Toulouse-Pièron test were shown gender wise within the group of students surveyed in the additions parameters (A) and omissions plus errors (O + E) in the five days surveyed (1 to 5). The average values are presented, plus the standard error of the mean for each parameter per sex (F and M). It was found that for additions and omissions plus errors did not significant differences between the genders in the five days surveyed, indicating that they presented the same level of perception and attention. However the errors plus the omissions in the five days surveyed behaved above 20 % of the successes, which showed a lack of deep concentration in the group of students. This trend was maintained in the five days in which this test was applied, indicating that this group of students had difficulties in keeping their attention over time. (Table 1)

Table 1
Sex wise comparison of Toulouse-Pièron test of five days

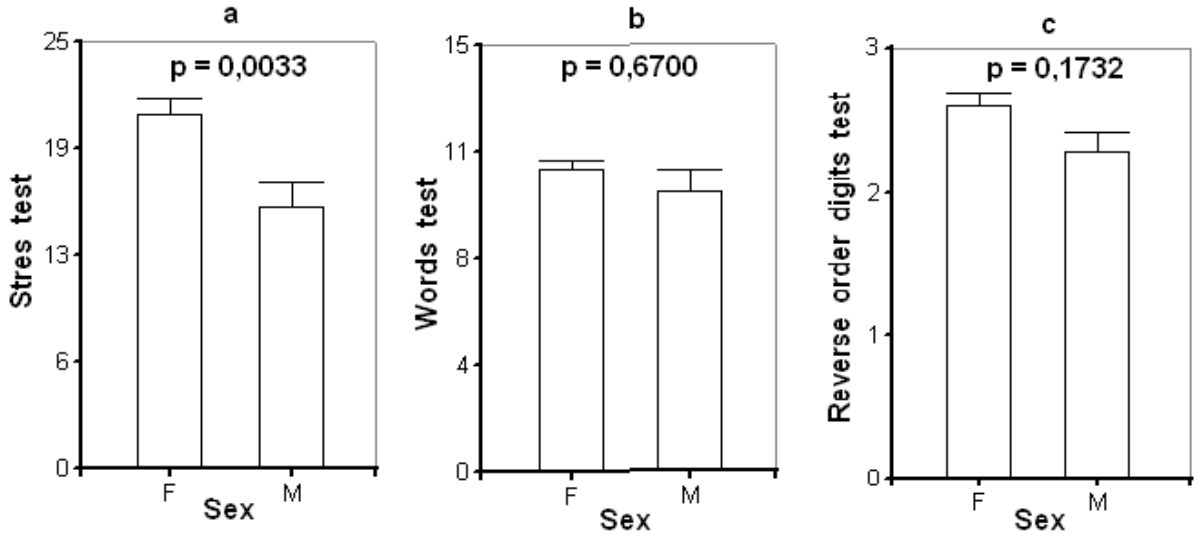
Day	Parameters	Female (Mean ± SE)	Male (Mean ± SE)	P Value
First	**A1**	20.91 ± 0.83	21.60 ± 1.18	0.6097
	O + E1	82.04 ± 10.33	64.71 ± 10.60	0.3006
Second	**A2**	21.26 ± 0.81	21.76 ± 1.16	0.6808
	O + E2	78.04 ± 8.10	65.21 ± 10.74	0.2336
Third	**A3**	21.27 ± 0.80	21.79 ± 1.21	0.6601
	O + E3	76.54 ± 7.64	63.57 ± 10.33	0.2335
Forth	**A4**	21.07 ± 0.80	21.31 ± 1.22	0.8426
	O + E4	74.44 ± 7.49	61.71 ± 10.21	0.2391
Fifth	**A5**	21.03 ± 0.82	21.81 ± 1.25	0.5233
	O + E5	75.04 ± 7.13	64.57 ± 10.51	0.2811

Note: $p \leq 0.005$ indicate significant differences between genders for each of the tests used applied[14]
A=Additions parameters (A), O=Omissions and E=Errors (O + E)

Stress test, word list and reverse order digits: The level of stress measured through the stress test applied to the group of students surveyed, found the existence of significant differences between females and males, which indicates that the effect of stress is manifested in a different way according to the type of sex ($p<0.005$). It was evidenced that female students stress is more than male students at that high school level of that institute in Ecuador. (Figure 1a)

In the case of immediate memory with the use of the word list test and the working memory through the reverse order digit test, no significant difference were found between sexes. (Figure 1b&c)

Figure 1
Sex wise stress test, word list and reverse order digits in study population



Relationship between stress and memory: No linear relationship was found between the effect of stress and the response to the word test to evaluate the ability to memorize, because in the analysis of the variance of the simple linear regression the stress variable did not significant differences (p = 0.9890).

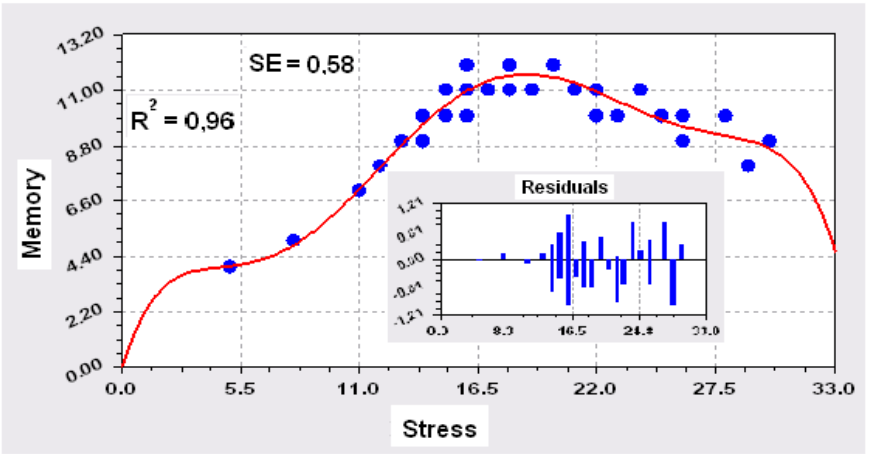
Based on this result, it was shown that within the different models of the non-linear regression the best fit corresponded to a degree six polynomial, as it was the nonlinear model with the highest coefficient of determination (R^2) and lower standard error, was also the model showing less dispersion of residuals versus predicted values. (Figure 2).

The determination coefficient (R^2), was 0.96; indicating that 96 % of the variation in the memory of the 40 students surveyed was explained by the effects of stress, although this relationship is not linear.

The results of the nonlinear regression (degree six polynomial), show that there was an influence of the stress on the memory, but it is not linear, that one must take into account the type of stress, the intensity, duration and the characteristics of the people (age, sex, etc). But it is shown that stress has an important influence in relation to altering cognitive processes such as memory

Figure 2.
Graphic representation relation between stress (x) on the memory (y) in study population

$y = a + bx + cx^2 + dx^3 + ex^4 + fx^5 + gx^6$



a = - 0, 0023251282
b = 2,7910376
c = - 0,75955888
d = 0,096902179
e = - 0,0055923255
f = 0,00014781239
g = -0,00001467604

IV. DISCUSSION

In this present study females were found to have significantly more stressed than males whereas immediate or working memory was without significant difference in both the sexes. It was also revealed that there was no relation between stress and memory.

Many researchers have found differentiated sex responses to stress conditions, with a marked trend of higher rates of stress in women in relation to men.[16,17,18]

Some research has not only found significant differences between gender in the perception of stress, but also in coping with stressful academic situations, such is the case of what was concluded by a study,[19] in which means resort to positive re-evaluation and planning strategies, while women prefer to seek greater emotional support. On the other hand,[20] evaluating the perception of stress and perfectionism in adolescent students, by physical activity and gender, did not find significant differences in the perception of stress.

Caldera et al., 2017,[21] evaluating explanatory and predictive models of academic stress response at baccalaureate level of a public entity in the state of Jalisco, Mexico, with the use of multiple linear regressions managed to build predictive models of stress generating situations such as family support, teacher help, school adjustment problems, relational victimization, dissatisfaction with body image and depression (first model). The second model was stress responses such as depression, dissatisfaction with body shape and sex.

Sustained psychosocial stress increases glucocorticoid levels and produces electrophysiological alterations that eventually generate dysfunction, atrophy and neuronal death in the hippocampus, all of which manifests as a severe cognitive deficit that it correlates clearly with manifest reduction of spatial learning and memory.[22]

The discharge of glucocorticoids by stress is essential to survive, but if this discharge is prolonged it becomes a serious risk to the health of a person by the appearance of immune suppression, diabetes, hypertension, hyperlipidemia, hypercholesterolemia, atherosclerosis, amenorrhea, childhood growth is affected and tissue repair.

Among the effects of the distress are an intense anxiety that hinders the concentration, the memory and other processes that decrease the performance and it prolong can trigger psychosomatic disorders.[23]

Frydenberg and Lewis (2000)[24] in an research into coping strategies employing high level students and by addressing gender and different ages in Toluca, Mexico, they applied the Coping Scale for Adolescents, found that the strategies that adolescents employ in the face of stressful situations were, strive and succeed, seek relaxing amusements, and worry. They also found that women employ more strategies focused on solving the problem with intervention of their emotions, while those of the male sex evade the problem and are more emotionally reserved. With regard to age, in 16 year olds students, strategies of evasion of the problem prevailed.

Celis et al., 2001[25] determining state anxiety and academic stress among students in the first and sixth year medical career of the National University of San Marcos, Peru, found that there are higher levels of anxiety status and trait in first year medical students than in sixth graders. They determined that among the main stress generating situations where the academic overload, the lack of time to fulfill the academic activities and the conduct of a test.

V. CONCLUSION

It can be concluded from this present study that females were significantly more stressed than males whereas immediate memory and the working memory were without significant difference in both the sexes. It was also revealed that there was no linear relation between stress and memory.

CONFLICT OF INTEREST

None declared till now.

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