Practical assessment strategy in human anatomy education, stress level and academic performance

Estratégia de avaliação prática no ensino de anatomia humana, nível de estresse e desempenho acadêmico

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ABSTRACT
Scientific evidences indicates a correlation between alterations of chronical origin and the stress created in academicals activities. Among the obligatory disciplines in health-related university programs, practical evaluation in Human Anatomy is one of the most feared, which seems related to anxiety, naiveness and superstitions in handling corpses. Furthermore, the psychological pressure in traditional evaluation methods seems to act as an important stress factor. The objective of this study was to evaluate the correlation between two methods of practical assessment of Human Anatomy, continuous and intermittent flow, level of cortisol and overall performance in college students from health-related programs. Thirty two students were recruited. Samples were collected before and after the first and second practical evaluation. The students themselves collected the samples assisted by a previously trained professional using Salivette tubes. The first evaluation was applied individually in intermittent flow (IF), switching between a practical question and a period waiting seated on a chair. The second was also individually, but in a continuous format (CF), without a stoppage. Levels of cortisol were determined by ELISA, utilizing the Salimetrics kit. The results point an increase of 46.8% in the level of stress of practical assessment strategy in the IF method. Nevertheless, a more expressive increase of 67.8% was observer in the CF method. In conclusion, IG method caused a smaller variation in cortisol levels and those have shown an inverse relation with student performance, indicating that the IG method may be a better way to apply practical evaluation in Human Anatomy Education.

Keywords: education, human anatomy, stress, cortisol, academic performance.

RESUMO
Evidências científicas indicam correlação entre alterações de origem crônica e o estresse gerado nas atividades acadêmicas. Entre as disciplinas obrigatórias nos programas universitários relacionados à saúde, a avaliação prática em Anatomia Humana é uma das mais temidas, o que parece relacionado à ansiedade, ingenuidade e superstições no manuseio de cadáveres. Além disso, a pressão psicológica nos métodos tradicionais de avaliação parece agir como um fator de estresse importante. O objetivo deste estudo foi avaliar a correlação entre dois métodos de avaliação prática da Anatomia Humana, fluxo contínuo e intermitente, nível de cortisol e desempenho geral em estudantes universitários de programas relacionados à saúde. Trinta e dois estudantes foram recrutados. As amostras foram coletadas antes e depois da primeira e segunda avaliação prática. Os próprios alunos coletaram as amostras assistidas por um profissional
previamente treinado usando tubos de saliveta. A primeira avaliação foi aplicada individualmente em fluxo intermitente (IF), alternando entre uma questão prática e um período de espera sentado em uma cadeira. A segunda também foi individualmente, mas em formato contínuo (CF), sem interrupção. Os níveis de cortisol foram determinados por ELISA, utilizando o kit Salimetrics. Os resultados apontam um aumento de 46,8% no nível de estresse da estratégia de avaliação prática do método IF. No entanto, um aumento mais expressivo de 67,8% foi observado no método CF. Em conclusão, o método IG causou uma variação menor nos níveis de cortisol e aqueles mostraram uma relação inversa com o desempenho do aluno, indicando que o método IG pode ser uma maneira melhor de aplicar a avaliação prática na Educação de Anatomia Humana.

**Palavras-chave:** educação, anatomia humana, estresse, cortisol, performance acadêmica.

**1 INTRODUCTION**

Stress has become a common affliction among adults and children alike, most of the times caused by psyche overload, which often results in psychological alteration, illness and degradation of the well-being. Because of that, the term stress is being used in a common-sense connotation, mostly referring to feelings of anxiety, tiredness, frustration and irritability (Dutta et al., 2005). Often affecting a high number of college academics, stress is caused due to excess of tasks, difficulty in time management, high demands on itself and excess of anxiety. Evidence shows that academics in health-related programs are more prone to stress levels in comparison to other areas (AlFaris et al., 2016). In this context, the academic environment, which has a role to build knowledge, ends up creating psychosomatic disorders, caused by the high levels of stress (Lovell et al., 2015; Yosetake et al., 2019).

In certain situations, the human body produces a hormone called cortisol, also known as stress hormone. Its function is related to several regulatory activities, which in abnormal levels can compromise vital functions, such as immune system causing a higher susceptibility towards diseases (Araujo, 2016). Cortisol levels can be measured by different biochemical methods in many sources of sample, like blood plasma, saliva and urine, binding or not to transport proteins (Stalder et al., 2012). Since blood sampling is considered a invasive
method that may cause an alteration in cortisol levels and have a high analyze cost, especially in high scale studies. Salivary cortisol measurement is one of most utilized methods when trying to analyze stress through a biomarker related to the hypothalamus-pituitary-adrenal axis activity (Hellhammer et al., 2009).

Hence, scientific evidences indicate a relation between chronical alterations and stress um academic activities. Among disciplines of health-related programs, practical evaluation in Human Anatomy is one of the most feared, often caused by anxiety, naiveness and superstitions in handling corpses. Additionally, psychological pressure in traditional methods of evaluation, short time for answering and strict rules seems elevate the stress factor. Thus, the aim of this study was to evaluate the effect of different strategies for the practical assessment of Human Anatomy, on cortisol levels and on the performance of academics in the health area.

2 MATERIAL AND METHODS

This is an analytical, quantitative and longitudinal study, in which volunteered academics participated, having been approved by the Ethic Committee in Research of the Federal University of the Triângulo Mineiro: nº. 4.492.091 CAAE: 29113720.2.0000.5154.

Initially, 32 volunteers were recruited, aged between 18 and 29 years, being 22 females and 10 males. Inclusion criteria were: be a freshman and attend Human Anatomy discipline, sign of the Explained and Free Consent Term. Also, all volunteers should follow all orientations and recommendations. Next, a physical evaluation and interview were scheduled, gathering data such as: personal data, daily habits, family history, disease history, psychological and psychiatric condition, sleep quality and use of drugs. Furthermore, volunteers couldn’t be under usage of prednisone, dexamethasone or any other steroids. Twelve hours before saliva sampling, volunteers were oriented not to make use of teas; energy drinks; sodas with cola; chocolate or chocolate milk. Food intake wasn’t allowed and also two hours before sampling, teeth brushing was not permitted. In cases of minor oral lesions, active or potential bleeding, saliva
sampling was not done and the volunteer were excluded. In cases of no agreement with inclusions criteria, orientations or recommendations, as well as abandoning the experiment, data from volunteers were excluded.

Saliva samples were collected before the start and after the finish of two practical evaluations of Human Anatomy of the Locomotion Apparatus. The first evaluation was applied individually in intermittent flow (IF), switching between one minute to answer a practical question and one minute seating in a chair waiting for the next question, this strategy aimed to relieve the academic from stress. Second evaluation was also individually, but in a continuous format (CF), without the need to switch between answering and waiting. Each evaluation consisted in 10 questions, randomly distributed and applied between 10:00 am and 11:00 am. Saliva sampling was done by the volunteer, assisted by a previously trained professional, doing the following procedure: with pre-washed hands, the volunteer extracted a cotton ball from the Salivette and put it in the mouth, chewing for 60 seconds, stimulating salivation. Using a sterile clamp, the professional assistant extracted the cotton ball and stored it inside the Salivette tube. The samples were centrifuged and the supernatant was stored in a -20º C freezer for later analysis.

Salivary cortisol levels were measured by ELISA – cortisol (Expanded Range), utilizing ELISA kit – 1x96 wells from Salimetrics, LLC. This method has an analytical sensibility of < 0.007 µg/dl and has inter and intra-assay variation coefficients of < 7% e < 11%, respectively, and shows no cross reactions prednisone and 17-hidroxiprogesterone (17OHP), but it has 0.56% reactivity with prednisolone and 19.2% with dexamethasone. The reference value for adults at 11:00 pm is 0.12 µg/dL. Sample preparation was done by coating the plates with monoclonal anti-cortisol antibodies (solid phase). Subsequently, 25 µL of standard sample and controls were added to the zero well and to the well with Non-Specific Binding (NSB). Next, 200 µl of conjugate was diluted by 1:1600 proportion (15 µl of conjugate to 24 ml of diluents). The plates were homogenized for five minutes at 500rpm and incubated for 55 minutes at room temperature. Afterwards, four washes were done with buffer solution and 200µL of TMB
(tetramethylbenzidine) solution was added, followed by homogenization for 5 minutes and incubation for another 25 minutes in the dark. Lastly, 50 µL of STOP solution was added and a period of waiting time of 10 minutes was executed. Absorbance readings were done in wavelength of 450nm. All reactions were executed at room temperature.

Statistical analysis was done using GraphPad Prism 5.0. Normal distribution was verified by ANOVA, followed by the post test of Bonferroni or t-student. Cortisol peak levels were evaluated by the Kolmogorov-Smirnov method and t-student. Pearson test evaluated correlation between methods of evaluations between IF and CF. Statistical differences were considered significant when p was lower than 5% (p<0.05).

3 RESULTS

At first, this study contemplated academics from different college programs health-related: medicine, physiotherapy, nurse and biomedicine. However, due to inclusion and exclusion criteria related to dietary restrictions and sample homogeneity factors, ten physiotherapy academics were selected (n = 10). Those had the following characteristics: 19.2 ± 1.3 years, 1.64 ± 0.05 meters of height, 64.3 ± 14.3 kilograms of body mass and 23.9 ± 4.0 kg/m² of Body Mass Index (BMI). Adopting BMI up to 24.9 as normal, overweight above 25 and obesity above 29.9, in 30% (n=3) the index indicates overweight, 10% (n=1) obesity and 60% (n=6) ideal body mass range. Approximately 40% (n=4) declared themselves white, 40% (n=4) black and 20% (n=2) brown, and none of them reported being a smoker.

Amongst the family history related to diseases, breast and prostate cancer, arterial hypertension, diabetes mellitus, heart attack and stroke were the most common. Related to their own clinical history, 80% of participants declared to already be interned, due to viral infection, anxiety, kidney stone, appendicitis, respiratory illness and small procedures. Of these, 60% (n=6) underwent surgical procedures: septoplasty, appendectomy and tonsillectomy. However, no participant reported the presence of autoimmune and infectious diseases.
One participant declared related chronical migraine of psychosomatic origin. Furthermore, 90% declared psychological issues, amongst them, one had psychological follow-up and three psychiatric following. The most common drugs were: birth control related, corticosteroids and anti-inflammatory related.

The participants had an average sleep of 30.5 hours a week and 15.2 hours on weekends and 50% of the total number of participants (n=5) declared to be adept of some religion. Anthropometrical variables, diseases history and sleep wellness haven’t shown relation to cortisol levels and performance of academics, detected by ANOVA followed by Bonferroni test (p<0.05).

Salivary cortisol levels before the first practical assessment (fig. 1) in IF had an average of 0.440 ± 0.047 μg/dL and 0.646 ± 0.178 μg/dL at the end. Therefore having a significant increase of 46.8% (p<0.01). However, there was a more expressive increase of 67.8% in the second evaluation in CF (p<0.001), in the comparison between the average of the initial concentration (0.438 ± 0.080 µg/dL) and the final (0.735 ± 0.137 µg/dL).

![Figure 1 – Salivary cortisol levels before the first practical assessment.](image)

Legend: Cortisol measurement before (Initial) and after practical assessments (Final). Statistical differences were detected by ANOVA, followed by the Bonferroni test.

Source: Own Authors

Although no significant difference was observed between the averages of cortisol levels (fig. 2) in the comparisons between CF and IF (p>0.05), a 44.2%
higher peak of salivary cortisol was observed in CF (0.279 ± 0.107 μg/dL), compared to the scavenger hunt in IF (0.192 ± 0.107 μg/dL). The difference was determined by the Kolmogorov-Smirnov method, followed by the Student's t test (p<0.05).

Figure 2 – Difference was observed between the averages of cortisol levels.

![Graph showing difference in cortisol levels between IF and CF](image)

Legend: Comparison of the cortisol peak in practical assessment in intercalated flow (IF) and continuous flow (CF).
Source: Own Authors

The results show an average of 56.50 ± 17.0% for IF and CF of 48.20 ± 10.8%, in which the assessment strategy was not able to significantly interfere of academic performance (p > 0.05), determined by the Kolmogorov-Smirnov method, followed by Student's t test (p<0.05). However, a correlation was identified between academic performance and the percentage of peak cortisol, IF (47.43 ± 29.7%) and CF (68.16 ± 26.1%), detected by Pearson's correlation test (IF: R²= 0.4802; p=0.263/CF: R²= 0.9481; p<0.0001).

In figure 3, a strong negative correlation can be observed, determined by Pearson's test (R²=0.948), in which the higher the stress level, the lower the performance of academics, especially CF.
The normal distribution graph of the cortisol peak percentage data illustrates the effective increase in the academic stress level (fig. 4), being more evident in CF.

However, when analyzing the normal distribution of academic performance data (fig. 5), as well as Pearson's correlation (fig. 3), it is evident
that stress levels have a greater negative effect on the performance of students of IF, with based on results of CF.

![Figure 5 – Distribution of academic performance data.](image)

Legend: Comparison of the normal distribution of academic performance percentage data: IF - Intercalated Flow; CF - Continuous Flow.

Source: Own Authors

Thus, by adopting a less stressful assessment strategy, such as IF, it established an opportunity for better academic performance for students. These findings are evidenced by the reduction of the adjustment of the linear correlation curve of the IF (Fig. 3a - $R^2=0.4802$) and by the displacement of the curves of normal distribution of the cortisol peak percentages (fig. 4) and academic performance (fig. 5).

3 DISCUSSION

The findings of our study confirm the hypothesis that practical human anatomy assessment activities are an important stressor. Therefore, IF provides less impact on the cortisol level, establishing an opportunity for better academic performance compared in CF.

A point worth mentioning is that the choice of assessment strategy did not significantly influence cortisol levels and the performance of students with basic and advanced knowledge levels. Therefore, only in students with an intermediate
level of knowledge, there was a greater impact on stress and performance in the evaluation in CF.

Historically, anatomy is considered one of the pillars of education in the health area, in which from the knowledge of the human body it is possible to develop clinical skills. Thus, only with a deep knowledge of human anatomy is it possible to establish safe practices, especially in the surgical area (Estai and Bunt, 2016).

The education of human anatomy requires constant review and analysis of education strategies, in the search for the adoption of increasingly adequate learning processes (Moxham and Plaisant, 2007). However, over time, a gradual reduction in the traditional model based on cadavers has been observed (Drake et al., 2009; Tibrewal, 2006).

Consequently, studies point to an inadequate reduction in the anatomy curriculum workload (Drake et al., 2009; Smith and Mathias, 2011), with a consequent increase in the incidence of iatrogenic procedures and constant reports of negligence litigation (Goodwin, 2000; Ellis, 2002).

Therefore, it is important to reflect on past practices, in order to establish future strategies that will guarantee excellence in anatomy education. Thus, when trying to review the history of practices in the early days of professors in human anatomy to the present day, we did not find scientific evidence on methods and assessment processes.

Thus, based on the reports of distinguished anatomist colleagues, it was possible to characterize that in the early days the main evaluative practices consisted of dissection procedures, individual oral assessments of identification and anatomical description. However, with the expansion of vacancies in universities and the legal difficulties in obtaining corpses, there was a need to adapt the evaluation process.

In this context, the practical classes became frequently expository and the practical assessment strategy, normally in CF. Thus establishing the traditional evaluation model, with the adoption of a short response period and strict control rules.
In study, the initial sample range included the main courses in the health area: medicine, physiotherapy, nursing and biomedicine. However, there was a drastic sample reduction with the application of inclusion and exclusion criteria, in addition to the adoption of a protocol with strict dietary restrictions. Therefore, to guarantee the homogeneity of the samples, the data of the genre and course with the largest sample number were used. In such a way, it was possible to select only ten female participants of the Physiotherapy course.

However, scientific evidence has shown a relationship between changes of chronic origin and stress from academic activities. Thus, changes are observed both in academics and in health professionals (Yildirim et al., 2017), in which in the latter this phenomenon seems to start during their academic training.

Cortisol peak at awakening is an excellent predictor of the response of the Hypothalamus-Pituitary-Adrenal axis, demonstrating a positive relationship between normal variations in cortisol concentration and the presence of diseases and psychic disorders, and can be used as a biomarker of these processes (Juster et al., 2011). However, cortisol concentrations vary throughout the day, as a result of the circadian cycle. Thus, high levels of this hormone are identified upon awakening, maintaining concentrations until the first hour of activity; with a gradual decline, to its lowest level, at night, at bedtime (Gagnon et al., 2018).

In view of the variation in cortisol levels throughout the day, all collections were always carried out between 10:00 am and 11:00 am, in order to ensure the standardization and reliability of the study. In addition, a standard collection procedure was adopted, in accordance with current recommendations and laboratory standards, in addition to ensuring an adequate calibration and dosage of the participants’ saliva aliquots.

Cortisol can be measured by different biochemical methods, being able to be quantified in different samples, due to the fact that it is bound to transport proteins in blood plasma, urine and saliva, peripheral form, or present in the active form in plasma, free cortisol (Stalder et al., 2012).

Thus, regardless of the cortisol measurement method, it is essential to pay attention to possible covariates that interfere with the circadian cycle (Adam and
Kumari, 2009). Therefore, a protocol for interviewing and monitoring the participants was established, recording personal data, daily life habits, family history, history of previous illness, psychological and psychiatric condition, sleep quality and medication use. In order to establish and apply appropriate inclusion and exclusion criteria, in addition to ensuring that restrictive dietary guidelines and recommendations were vehemently followed.

In this perspective, our findings are strong enough to alert about the repercussion of stress on academic performance and the constant need to review and adapt assessment methods. However, it should be noted that the impact on academics' performance is probably multifactorial, in which the negative effects cannot be solely attributed to the methodological choices adopted in the education of human anatomy.

4 CONCLUSION

The intermittent practice assessment strategy had less impact on cortisol peaks, an indication that this method may be a better choice when compared to the continuous method. Furthermore, cortisol levels had an inverse relationship with academic performance, where the continuous method had a more negative impact on stress levels and performance.

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