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Negative Events, Coping and Biological Markers: An Application of Transactional Model of Stress*,**

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ABSTRACT – Based on the importance of the stress phenomenon, this research sought to evaluate the relationship between stress, coping strategies, negative life events and biological markers, based on the Transactional Stress Model. A general hypothesis of mediation was formulated: coping strategies would mediate the relationship between negative life events and biological markers. The sample consisted of 96 users of a biomedical school laboratory, in which 77.78% were female. Participants answered the Brief COPE questionnaire, as well as a questionnaire on negative life events. Laboratory tests were collected shortly after the application of the questionnaires. Mediations were found between Venting, Red Blood Cells and Hemoglobin. The research aimed to contribute to the knowledge in the field of stress and coping, as well as to serve as a possible empirical study of the Transactional Stress model.

KEYWORDS: Coping, negative life events, Stress Transactional Model, Stress

Eventos Negativos, Estratégias de Enfrentamento e Marcadores Biológicos: Uma aplicação do Modelo Transacional do Estresse

RESUMO – Dada a importância do fenômeno do estresse, esta pesquisa procurou avaliar a relação entre estresse, estratégias de enfrentamento, eventos negativos na vida e marcadores biológicos baseados no modelo transacional de estresse. A hipótese geral de mediação é que as estratégias de enfrentamento seriam mediadoras à relação entre eventos negativos na vida e os marcadores biológicos. A amostra consistiu de 96 usuários de um laboratório escola em que 77,78% eram mulheres. Participantes responderam ao questionário Brief-COPE, assim como o questionário de eventos negativos na vida. Os testes laboratoriais foram coletados logo após a aplicação dos questionários. As mediações foram encontradas entre auto-distração células vermelhas e hemoglobina. A pesquisa buscou contribuir com o conhecimento na área de estresse e estratégias de enfrentamento, assim como servir como estudo empírico do Modelo Transacional de Estresse.

PALAVRAS-CHAVE: Estratégias de enfrentamento, eventos negativos, Modelo Transacional do Estresse, Estresse

Considered by the World Health Organization as the epidemic of the 21st century, reaching 90% of the population, stress is one of the most interesting constructs nowadays (Fink, 2016). Its importance is so great that it is characterized as an object of study from biological sciences to social sciences. The present research is part of a series of investigations on the subject of stress, and aims to evaluate the relationship between stress, negative life events, coping strategies and biological markers in an exploratory way.

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STRESS

Although it is a phenomenon already experienced by everyone at least once, stress is difficult to be defined. Hans Selye, known as the Father of Stress, states that "Everyone knows what stress is, but no one really knows" (Selye, 1976). This initial definition describes stress as a non-specific body response to any demand, but the concept was modified over the years of research, and a variety of new interpretations emerged (Fink, 2016, McCarty, 2016). Nevertheless, it is important to note that the understanding of stress varies according to the perspective under which it is analyzed.

There are distinct approaches to the field of stress research: the Stimulus concept, the Response concept, the Transactional and the Discrepancy approach (Sonnentag & Frese, 2003). The first focuses on situational conditions or events. In other words, the stimuli are stressful. Although this approach was criticized, many researchers agree that there are some stimuli that evoke strain in most individuals (Sonnentag & Frese, 2003). The second, defended by Selye, states that stress exists if an individual shows a specific reaction pattern. This approach also received critics because it does not take into account that different people present different types of coping strategies that can alter the stress response. The other two approaches, Transactional and Discrepancy, take into account that the interaction between individual and stress event is what defines stress. The Transactional approach, from Lazarus and Folkman, suggests that the interaction between the individual's perceptions, interpretation and coping strategies plays a role (Krohne, 2001; Lazarus, 1993a,b), and the Discrepancy concept describes stress as a distance between desires and what is provided by the environment (Sonnentag & Frese, 2003).

These interpretations open possibilities for the understanding of stress as a phenomenon, not only negative, but also of positive valence. Positive stress would be the type that prepares the individual to face potential challenges, while negative stress is divided into two categories (McEwen, 2016). The first represents tolerable stress, which refers to a daily situation to which the individual can adapt and/or face due to enough internal and/or external support. The second category is toxic stress, in which the individual experiences situations for which he or she does not have the necessary support, resulting in adverse physical and mental consequences (McEwen, 2016).

These consequences can be seen in the well documented effects stress has on the cardiac system (Rogers, 2016), immune functioning, the excretion of hormones (Costa et al., 2016; Martin & Dobbin, 1998), and its association with affective and behavioral reactions (Sonnentag & Frese, 2003). However, stress has shown mixed results in relation to some of those variables, depending on the reaction the individual has to it (Pulopulos & Kozusznik, 2018). As an example, a study by Keller et al. (2012) sought to assess the relationship between the amount of stress experienced, the perception that stress affects health and the impact on health and mortality rates. The study had a sample of 30,000 Americans and, by using public records to monitor mortality, concluded that individuals who reported high levels of stress and the perception that stress was detrimental to health had a 43% increase in the risk of death, while those who reported high levels of stress but did not present the belief that stress was harmful had the lowest mortality rate. Another study by Jamieson, Mendes and Nock (2013) reported that it is possible to rethink the physiological responses from stress as positive, thus avoiding the negative health effects commonly associated with the phenomenon.

These studies go in accordance with what is proposed by the researchers' choice of approach, the Transactional Model. It was developed by Lazarus and Folkman (1984) and describes stress as a subjective process involving cognitive evaluation and coping strategies, with empirical support (Pulopulos & Kozusznik, 2018). In this model, we do not study stress by separating the stimulus from the individual, but from the point of view that there is a transaction in which the individual must constantly adapt to the stressor. These stressors are challenging environmental circumstances to which individuals respond (Hulbert-Williams, Morrison, Wilkinson, & Neal, 2013, Biggs, Brough, & Drummond, 2016, Monroe & Slavish, 2016).

In the presence of stressors, the individual evaluates their significance and potential threat in order to judge it as stressful, positive, controllable, challenging or irrelevant. This process is known as primary appraisal. The next step is the assessment of the individual's resources to deal with the stressor, called the secondary appraisal. The wide variety of assessments made by individuals in the same environment can be explained by the use of two variables during the transaction: individual aspects such as values, goals and beliefs; as well as external aspects, like demand and resources. After the two appraisals, the individual employs the coping strategy chosen (Erbas, Ceulemans, Kalokerinos, & Houben, 2018; Evans & Cohen, 1987; Biggs, Brough, & Drummond, 2016).

The main premise of the model is that coping assessments and coping strategies mediate the relationship between stressor and the consequences of stress. Considering it is the perception of the event and how we deal with it that is stressful, not the event itself (Goh & Oei, 2010).Cobb (1974), suggested a moderator effect, but also described the mediator effects of social support in life stress (Pulopulos & Kozusznik, 2018).

COPING

The resources of the individual to deal with stress involve coping strategies, defined by Lazarus and Folkman (1984) as constantly changing cognitive and behavioral attempts to deal with a specific internal or external demand to avoid suffering. These strategies can be classified according to the focus. Those who deal directly with the stressor are focused on the problem, while those dealing with the emotions arising from the stressor attempting to alleviate suffering are focused on emotion (Dantzer, 2016).

One of the factors that influences the strategy used is the personality trait. Lazarus (1993b) states that the traits influence the evaluation process of the stressor and individual resources, thus influencing the strategies used. A study by Ball, Smolin and Shekhar (2002) found that optimistic individuals tend to assess the situation more positively and to choose more proactive strategies, whereas more pessimistic individuals tend to underestimate their abilities, assessing the situation negatively, and choosing passive strategies. However, no relation was found between optimistic and pessimistic people in the cortisol levels (Puig-Pérez et al., 2018), but Martin and Dobbin found a moderated effect by the styles of Humor (1988).

Lazarus (1993a) also brings the procedural perspective of coping, in which it is understood that strategies can change over the years and are subject to adaptation according to context. Literature suggests that the higher the level of flexibility in the use of coping strategies, the better the level of adaptation of the individual to stressful situations (Cheng, Lau, & Chan, 2014). This suggests we, humans, are dynamic and that individual-environment interactions are of the utmost importance.

Different authors propose different coping strategies because of the multifaceted nature of the phenomenon. This study adopted the strategies proposed by Charles Carver (1997), based on the work of Lazarus and Folkman. The strategies are described in Table 1.

In order to define whether a coping strategy is adaptative or maladaptive, one must analyze the context and function that the strategy has at that particular moment. This definition varies between individuals and depends on short-term and long-term appraisal, but it is important to keep in mind that no strategy is appropriate for all situations. The primary appraisal will determine the nature of the situation, and during the secondary appraisal the best coping strategy will be selected. In the end, based on the result of the use of strategies and new environmental information, a reassessment is made in order to ascertain the success of the process (Biggs, Brough, & Drummond, 2016; Sonnentag & Frese, 2003).

Most people vary the strategies used to fit the stressor and resources available, which means there is no accurate way to predict what strategies a particular individual will use in the face of a specific problem. The best adapted individuals tend to use different forms of coping for the same stressor, varying according to the stage of the stressor (Erbas et al., 2018; Maia, Sendas, Lopes, & Mendes, 2016; Stephenson, King, & DeLongis, 2016). Also, researchers found that, despite sharing similar circumstances (oncologic illness - Al

Table 1

Coping strategies and their definitions

Strategy	Definition
Active Coping	There is a concentrated effort to deal with the situation in which the individual finds himself, in order to solve the problem.
Planning	The individual thinks and tries to work out a plan of action.
Positive Reframing	The focus is trying to see the situation from a more favorable perspective, trying to make the best of the situation.
Acceptance	It occurs by accepting that the stressor is real. The individual seeks to learn to deal with this reality.
Humor	Individual jokes about what happened.
Religion	There is an increase in participation in religious activities.
Using Emotional Support	The individual seeks emotional support from someone. Seek comfort and understanding.
Using Instrumental Support	Marked by the search for help, information or advice on what to do.
Self-Distraction	There is a mental disinvestment about the stressor, and the individual seeks to distract himself with other things, such as work.
Denial	Attempt to reject the reality of the event.
Venting	Individual vents, expresses his feelings about what happened.
Substance Use	Individuals use drugs, alcohol, or drugs as a means of divestment.
Behavioral Disengagement	Observed when the person gives up trying to deal with what happened.
Self-Blame	The individual blames himself and criticizes himself for what happened.

Jadili & Thabet, 2017; Iamin & Zagonel, 2011; emergency unit professionals - Ribeiro, Pompeo, Pinto and Ribeiro, 2015), the strategies used by the participants varied according to different contexts and situations. These results show that coping strategies vary between people and they are useful to mitigate health pain and challenges.

PHYSIOLOGICAL ASPECTS

In addition to being a cognitive process, stress is physiological. When the brain perceives a stressor, it activates the Autonomic Nervous System (ANS) and the Neuroendocrine System, which elevates the catecholamine levels (adrenaline, noradrenaline and cortisol (Pulopulos et al., 2018) in order to prepare the body to cope with danger. The hormones cause physiological changes, such as increased heart rate, dilated pupils, reduced digestion, elevated blood sugar levels and contraction of the spleen, which upsurges the amount of red blood cells, increasing the supply of oxygen to the tissues. This initial response acts as an alarm (Bauer, 2002). The second system, the hypothalamus-pituitary-adrenal axis (HPA-axis), is regulated by a negative feedback system which is mainly performed by the frontal cortex, amygdala and hippocampus which regulate the return to basal levels (Pulopulos et al., 2018). Those areas of the brain tend to be activated when processing negative rather than positive information and are associated with automatic evaluative processing. There are some evidences that stress hormones have negative effects in the HPA-axis (Ahs et al., 2006; Miller, 2013).

The inevitability of facing stress leaves individuals vulnerable to disease, since the reaction to stressors causes immunosuppression, that is, reduction of the defenses of the organism, during the preparation to face the danger. Cardiovascular pathologies, such as arteriosclerosis and strokes; metabolic pathologies, such as insulin-resistant or type 2 diabetes; gastrointestinal pathologies, such as ulcers; reproductive pathologies, such as impotence and miscarriage; among others, are associated with chronic stress (Bauer, 2002; de Kloet, 2016).

Because it is the hormone most commonly associated with stress, cortisol, the main glucocorticoid produced and secreted by the adrenal cortex, is the champion in scientific research. The study conducted by Pulopulos and Kozuzsnik (2018) described a moderated relation between stress and cortisol for individuals with low levels of meaning of life, operationalized as the degree of activities that one is engaged in and was personally valued and important, in other words, that resembled coping strategies in some sense. This is an example of the type of study held comparing biological markers with psychological constructs. Another common laboratory test in the physiological research of psychological aspects is Vitamin D, often associated with depression. An example is the literature review made by Parker, Brotchie and Graham (2017). This review sought to examine whether vitamin D deficiency or insufficiency may be associated with depression and whether supplementation may be an effective treatment. The research concluded that there is growing evidence of the link between the two factors, but there is still a need for more elaborate empirical studies.

However, there are other tests that can be analyzed to assess the biological impact of stress. A systematic literature review by Allen et al. (2017) on the effects of chronic stress in informal caregivers of patients with dementia examined 151 articles that sought to measure the impact of stress through cognitive and/or biological markers. In addition to cortisol, the authors list studies that used glycemia and immune system markers, such as lymphocytes and C-reactive protein, used to detect infections.

C Reactive Protein also appears in other studies, as in the case of Shimano e et al. (2018), who evaluated the impact of social support and coping strategies on the relationship between perceived stress and CRP; or by Rosen et al. (2017), who evaluated the relationship between CRP and post-traumatic stress in survivors of the Sept. 11 attacks; and O'Donovan et al. (2017), who evaluated the symptoms of post-traumatic stress in American veterans and reported a positive relationship with CRP.

The present study, unlike previous studies, seeks to outline a more comprehensive picture, not focused on a specific health condition and patient samples. In addition, it will not only focus on cortisol and vitamin D, the two most common tests, making an exploratory collection in order to check other possible relevant relationships. In order to reach that goal, a variety of biological markers, defined as cellular, structural and biochemical components that can delineate cellular and molecular changes in cells, was used, all in the form of blood tests (Capelozzi, 2001).

The tests, described in Table 2, were selected because they show a connection with the immune, endocrine, or stress system (Williamson & Snyder, 2015). Serotonin, which is also frequent in this line of research, has been eliminated from the list, since its collection requires an prior preparation that does not match the type of collection performed in this study.

Table 2

Laboratory tests and their definitions

Exames	Definition
Cortisol	Called stress hormone. There are many functions of cortisol beyond stress. The secretion of this hormone is controlled by the hypothalamus.
TSH	Hormone secreted by the adenohypophysis, which controls the biosynthesis and release of thyroid hormones, T3 and T4. The thyroid regulates body metabolism, and has great impact on the control of emotions, memory, concentration and mood (Rodrigues, De Toledo, & Nogueira, 2015).
Glycemia	Measures the amount of a type of sugar, called glucose, the main source of energy used by the body. It is associated with metabolic disorders, such as diabetes. It is released into the blood as a response to the stressor, which means that a high value, associated with increased epinephrine (adrenaline), may indicate stress.
C Reactive Protein (CRP)	Protein produced in the liver, useful for the detection and evaluation of infections. It is the main marker of the acute phase of inflammatory and necrotic processes (tissue death).
Complete Blood Count: RBC, Leukocytes, Hb, Ht, platelets.	The complete blood count (HC) is a report of blood elements. It consists of counting white cells (leukocytes), red blood cells (RBC), hemoglobin (Hb), hematocrit (Ht), and platelets. It is used to identify and monitor abnormalities such as anemia and bacterial and viral infections.
Ferritin	Iron cell storage protein which, together with transferrin and its receptor, coordinates cellular defense against oxidative stress and inflammation. It is used to monitor iron levels in the blood, rising when there is inflammation.
Vitamin D	Group of fat-soluble compounds responsible for the structuring and maintenance of bone tissue and balance of calcium and phosphorus levels, important for homeostasis. In addition, it acts on the immune system.

METHOD

Participants

The present study analyzed the responses of 96 participants, of both genders, aged 18 years and over (M = 43.85, SD = 16.20). The inclusion criteria were being over 18 years old, understanding Portuguese, having fasted for 8 hours, and agreeing to participate in the study. The exclusion criteria were having previous diseases (diabetes, cancer or other that could bias the blood markers), and not meeting the inclusion criteria.

All participants were Brazilian, residents of the Federal District and clients of a university laboratory, located in Brasília-DF. This laboratory usually serves the needs of low-income groups but is open to the general population. The total number of respondents was 105, but only 96 answered all the instruments and had all the necessary blood work. Respondents were invited to participate in the survey on a first come, first served basis. The first six patients in line at the laboratory were invited to participate in the study, and in case of no interest or impossibility to meet the criteria, the spot was offered to the following patient. The restriction of six participants was due to the limited number of comfortable seats for the waiting time required for cortisol analysis. The necessary tests for the study were added to the ones already requested by the participant's doctors at no cost. The purpose of their visit to the laboratory included routine analyses and job admission exams, amongst others. In general, women were more willing to participate, making up 77.78% of the participants (84 females).

With regard to schooling, 17 participants (15.74%) had only elementary education, 57 (52.78%), high school and 19 (17.59%), higher education. The others, corresponding to 13.89% of the participants, were illiterate. In these cases, the researcher read the questionnaire aloud individually so that they could participate.

Instruments

The first instrument used was the Brief Cope Questionnaire (Carver, 1997), adapted to the Portuguese version by Pais-Ribeiro and Rodrigues (2004) and Marôco et al. (2014). This instrument is composed by 28 items that seek to evaluate the coping strategies most used by the participant, who are instructed to specify how often each strategy is used. The frequency is indicated by a 1 to 4 scale, in which number 1 means never and 4 represents high frequency.

The 28 items denote two statements of each of the following strategies: Active Coping (α .56), Planning (α .40), Positive Reframing (α .60), Acceptance (α .57), Humor (α .79), Religion (α .79), Instrumental Support (α .50), Self-Distraction (α .24), Denial (α .44), Venting (α .84), Behavioral Disengagement (α .75), Self-blame (α .71) and Emotional Support (α .60).

The second instrument used was an adaptation of the Life Events Questionnaire developed by Saranson et al. (1978), modified by Norbeck (1984), and adapted for the present research. The original questionnaire consists of 82

items that seek to identify which life events occurred in the previous year, whether positive or negative. Due to the focus of the study, during the translation, the researchers selected only the negative events. In a pre-test with the same group in the university laboratory, the respondents showed difficulties to understand the full scale. It was decided to dichotomize the scale in order to be more understandable for the target demographic. They were asked to indicate any event that had occurred in their life in the previous twelve months. The final result used was the total sum of the negative events reported.

Participants also answered a brief sociodemographic questionnaire with the following demographic data: age, gender, educational level, work, history of disease (thyroid problems, cancer, diabetes and depression), exposure to the sun and physical activity. All the participants signed the terms of informed consent.

The biological markers were evaluated through the analysis of the following laboratory tests: basal plasma cortisol (mandatory rest 20 minutes before the test), thyroid hormone, glycemia, C-reactive protein, complete blood count, serum ferritin, and vitamin D. Samples were withdrawn after the required 8 hour fasting period and stored in vacuum tubes with 4 ml capacity separator gel.

Procedure

Data collection. The project, which is part of a larger study that also analyzes the relationship of psychological constructs with biological markers, was approved by the Ethics Committee, by protocol number 51340715.2.0000.0023, on 05/05/2016.

In order to initiate data collection, the researchers briefly presented the study to the clients present at the lab and all those who agreed to participate in the survey had the laboratory tests offered free of charge, limited to 6 per day due to the comfortable seats available to the respondents.

The collection started daily at 7am. The questionnaires were answered while the clients waited for the blood samples to be taken, after signing the Informed Consent Term. The necessary time to complete the questionnaires varied greatly, taking from 15 minutes to over an hour, depending on the level of instruction of the participant.

The laboratory team, composed of biomedicine students, used ELISA assay methods to analyze the samples and results of the exams, identified only by the protocol number, were made available by the person in charge of the laboratory. They were then inserted into a database, along with the data from the questionnaires.

Data analysis. The bank data were transferred to the SPSS software, where an initial analysis of the correlations was made. From the correlations found, possible triads of mediation were listed, with coping strategies serving as mediators between negative events and biological markers. Alpha's reliability tests were conducted (and it was between 0.6 and 0.9) to confirm if it was possible to use the instruments. Normality assumptions were tested. Two participants showed non-normal TSH (75.0 and 6.3) and were discarded. Four participants were slightly above 125 in glycemia, and it was decided to keep them because it would not disturb the analysis as they did not have different results in any other dimension. Enter regressions were conducted and Hayes process was used to test the mediation (Model 4). The Sobel test was conducted using software available in Preacher and Leonardelli (2001) homepage.

RESULTS

Because of the exploratory nature of the research, the correlations between all the variables were initially analyzed to map the relationships. Only the significant results were described in Table 3. Cortisol, Glycemia and T3 show no significant result with any of the coping strategies.

Keeping the exploratory character, correlations between coping strategies and negative events were also tested. The results are described in Table 4. Self-distraction, Active Coping, Emotional Support, Instrumental Support, Positive Reinterpretation, Planning, Acceptance and Religion show no significant results with negative events.

From the inspection of Tables 3 and 4 and the regressions that confirm the relations, it was decided to test mediation models as a function of the relationship pattern found among the variables, establishing, as a general hypothesis, that coping strategies will serve as mediators in the relationship between negative events and biological markers. The criterion used to select the variables submitted to the mediation test was the existence of a correlation between negative event and coping strategy, and between coping strategy (substance use, venting and self-blame) and biological marker. In order to test the mediations, linear regressions were performed prior to the Sobel test (Preacher & Leonardelli, 2001). The results are shown in Figures 1, 2 and 3.

Figure 1 shows a full mediation model test with substance use as a mediator of the negative event and Leukocytes ($\beta_{indirect}$ = -.07; Zsobel = .00; p = *ns*) and CRP ($\beta_{indirect}$ = -.08; Zsobel = .43; p = *ns*) relation. None of the relations were significant.

Figure 2 shows a full mediation model test using venting as a mediator. In the case of Red Blood Cells (RBC) ($\beta_{indirect}$ = -.04; Zsobel = -3.63; p <.01) and Hemoglobin (Hb)

Table 3

Correlations between coping strategies, negative events and biological markers.

	Ferritin	RBC	Hemoglobin	Hematocrit	Leukocytes	Platelets	CRP	TSH	Glycemia	Cortisol	T3	T4	Vit. D
Substance Use	-.03	.03	.03	.07	.19*	.05	.23*	.08	-.07	-.05	.12	-.04	-.05
Emotional Support	.05	-.17	-.18	-.20*	-.06	-.20*	.06	-.15	-.11	-.04	-.11	.15	-.15
Venting	-.16	-.20*	-.29**	-.24*	.03	-.09	.06	.05	.02	.12	.11	-.14	-.11
Instrumental Support	-.06	-.03	-.15	-.11	-.07	-.01	.06	-.06	-.18	.03	.03	-.23*	-.06
Positive Reinterpretation	.03	-.10	-.04	.00	.11	-.08	.08	-.20*	-.09	-.06	.07	-.15	-.12
Self-Blame	-.08	.10	.00	.00	.14	.19*	.33**	.15	-.08	-.15	-.12	-.06	-.11
Planning	-.08	-.08	-.09	-.08	.02	-.15	.05	-.16	-.19	-.02	.05	-.24*	-.25*
Religion	-.27**	-.29**	-.37**	-.30**	-.03	.00	-.03	-.10	-.05	.00	.03	-.26**	-.21*
Negative Events	.02	-.15	-.14	-.06	.02	.08	-.03	.25*	-.05	-.19	.03	-.03	.02

Notes: *$p \leq .05$; **$p \leq .01$

Table 4

Correlations between coping strategies and negative events

Strategies	Negative events
Denial	.23*
Substance Use	.35**
Behavioral Disengagement	.35**
Venting	.22*
Self-Blame	.28**
Humor	.34**

Notes: *$p \leq .05$; **$p \leq .01$

($\beta_{indirect}$ = -.06; Zsobel = -2.00; p <.05), the effects were significant. However, Hematocrit shows no relation ($\beta_{indirect}$ = -.05; Zsobel = .43; p = *ns*).

Finally, Figure 3, describes the full mediation model test using self-blame as a mediator. In both analyses, the mediations were not significant, neither with Platelets ($\beta_{indirect}$ = .05; Zsobel = .03; p < *ns*) nor with CRP ($\beta_{indirect}$ = .09; Zsobel = .66; p = *ns*).

Figures 1, 2 and 3 illustrate the results found in the mediations tested during data analysis. It is possible to observe the relations between Venting and Hemoglobin and Red Blood Cells, characterized as total mediations.

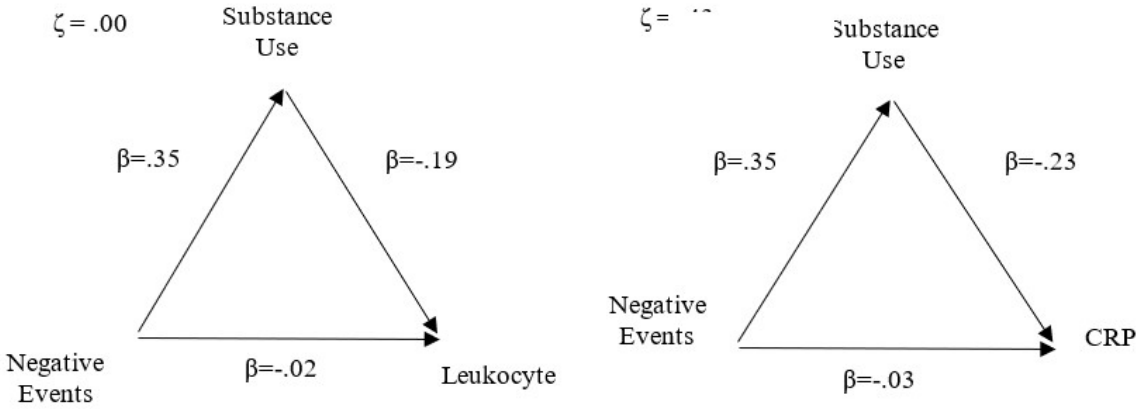

Figure 1. Mediations using substance use as a mediator.

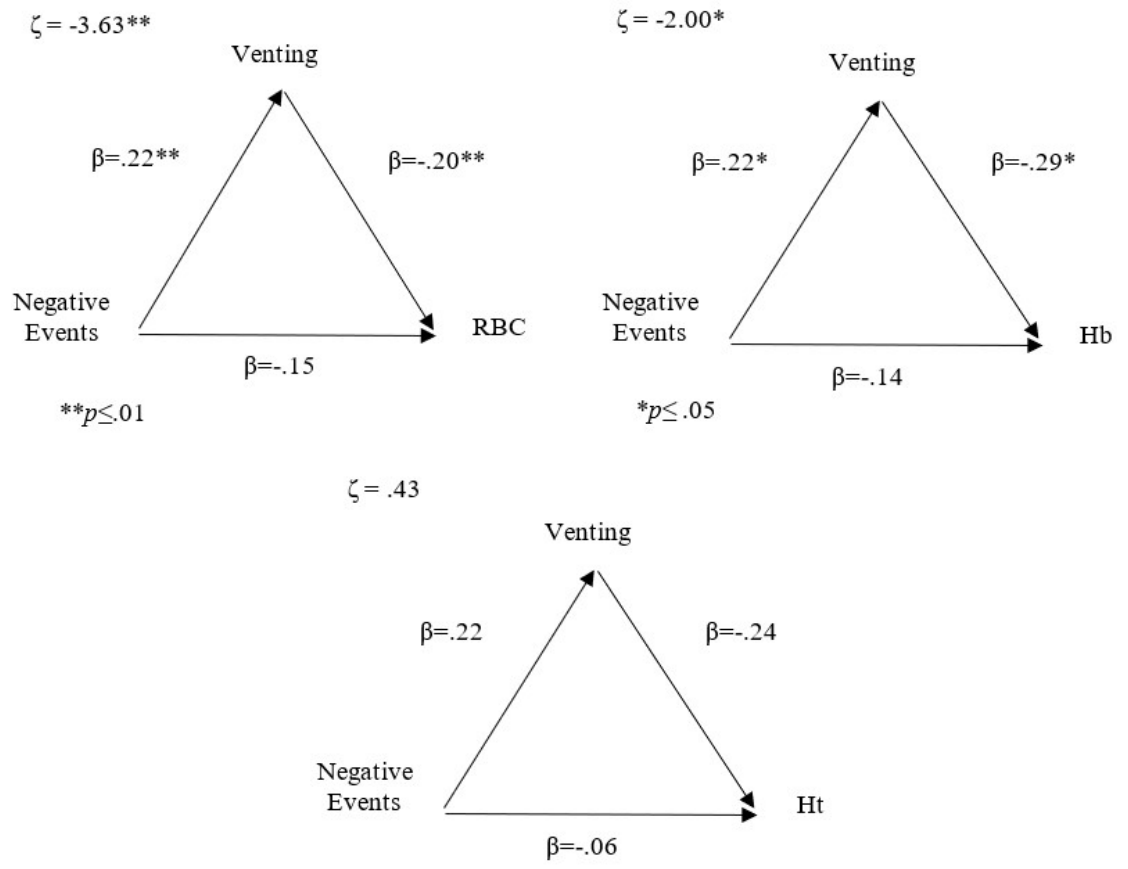

Figure 2. Mediations using venting as a mediator.

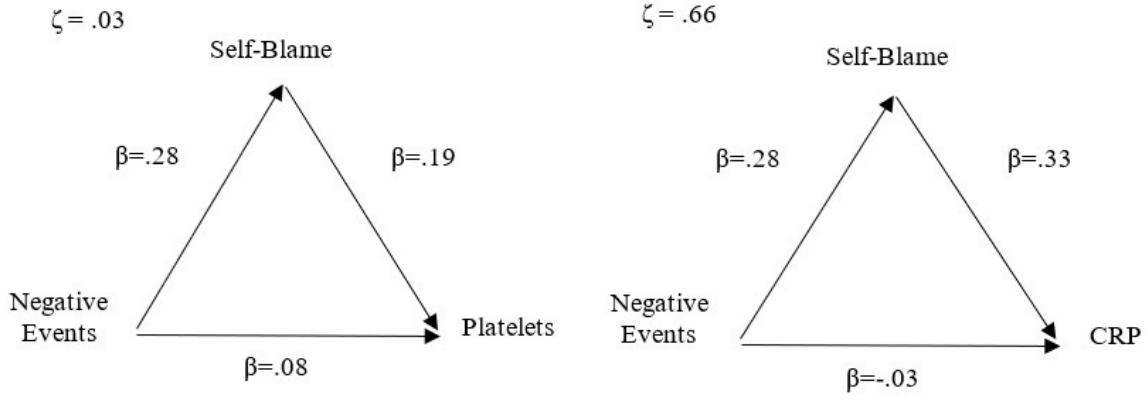

Figure 3. Mediations using self-blame as a mediator.

DISCUSSION

The objective of this study was to evaluate the relationship between coping strategies, negative events and biological markers. No specific hypotheses were formulated due to the exploratory nature of the research. However, a general hypothesis was adopted based on the Transactional Model, the theoretical model of stress that bases the present research, having as main premise the understanding that coping strategies mediate the relationship between the stressor and the physiological reflexes of stress (Goh & Oei, 2010; Pulopulos & Kozusznik, 2018).

In order to test this general hypothesis of mediation, first, the direct relations between the variables were evaluated. It

was possible to verify that relationships identified in previous studies, such as Sladek, Doane, Luecken and Eisenberg (2016), among stressors, coping strategies and Cortisol were not significant in the present study. One possible explanation is due to the mean that was used for the cortisol test. We collected cortisol in the blood and the best practice is the salivary cortisol. Another possible explanation is related to the negative events. Though there was relation with coping, a stronger relation might be possible if we could ask how much those negative events affected the individual's life. The original questionnaire is designed in this format, but the respondents, in general, left them blank, either due to embarrassment or not understanding the question.

Some relationships not commonly discussed in the literature, such as the correlation between Venting and Hemoglobin, Hematocrit and Red Blood Cells are significant. Venting decreased the levels of those variables that are responsible for the transport of oxygen throughout the body. In this case, it could be related to symptoms like fatigue. The specifics of how the mechanism of venting could be related to reduced Hb, Ht or RBC are unknown, but they could be explored in future studies. Venting could be considered a maladaptive coping strategy.

CRP also showed a correlation with Self-Blame and substance use, which is notable because it is a biological marker for inflammatory process (Fischbach, 2005; Williamson & Snyder, 2015). High levels of CRP have no clear implications apart from indicating an infection. However, those infections could be related to high probability of a heart attacks or cancer, thus, indicating that the body is suffering and needs to be regulated. In this case, we could say that self-blame and substance use are maladaptive coping strategy for this population, but more studies need to be made to test this thesis. Although these indicators result in bad body condition, it is necessary to highlight that, in this study, the participants did not have any especial bad health condition, and also did not present level out of what is considered acceptable or normal.

Another interesting fact is the role played by Religion as a coping strategy, having presented positive relations with Ferritin, Red Blood Cells, Hemogram, T4, Hematocrit and Vitamin D. The results point out a need to investigate relationships beyond those commonly studied in order to analyze possible explanations and promote a better understanding of the physiological effect of stress and coping strategies. Religion, for example, can be interpreted as meditation, hope or social support, and it is not clear if all these possible interpretations perform at the same time or if there is any predominance, questions which will be kept open for future studies.

Another important finding of the present study is the low number of correlations between negative life events and biological markers. Such a result can be considered an indicator that events are not stressful in and of themselves, but that the perception and evaluation of the individual that experiences them dictate the possible effect of the event (Lazarus, 1984). In other words, even if the events listed in the instrument are considered *a priori* aversive, participants may not have evaluated them as such.

After evaluating the direct relationships, we proceed to the mediation test. According to the general hypothesis of the Transactional Stress Model, coping strategies serve as mediators between the stressor and the biological marker. In the present research, only two mediations were significant. The strategy Venting was configured as a mediator between Negative Events and Red Blood Cells, and between negative events and hemoglobin, corroborating the general proposition of the Transactional Stress Model, proposed by Lazarus and Folkman (1984). These findings demonstrate the impact of coping strategies on understanding aspects related to stress. Faced with negative situations, higher indexes of Venting, that is, a greater tendency of the individual to vent and talk about how they feel due to the negative event, had an impact on biological markers that are related to possible infections. This demonstrates the importance of this strategy, since its use can have a positive impact on health. The other mediations found were not statistically significant.

Throughout the research, some limitations were found. One of the main concerns was the low reliability of some measures. Although it has been seen as a limitation, it is emphasized that many of the alphas found are close to those identified in the Portuguese adaptation such as Religion (.80), Acceptance (.55), Behavioral Disengagement (.78) and Substance Use (.81) (Pais-Ribeiro & Rodrigues, 2004).

Despite the limitations, the present research has important contributions, mainly due to the inclusion of biological markers not commonly tested in research of this nature. In addition, in the reviewed literature, no research was found that used such a large variety of coping strategies in tandem with this many biological markers. In addition, the research does not focus on a single group or patients with a specific comorbidity, in particular the sample was particularly interesting as it included low-income people, it describes a population where stress has, maybe, different pattern in stress response (Aneshensel, 1992), and there were no specific sample bias (some comorbid). Concerning the possible applications, the research proposed a possible practical model to test the premises of the Transactional Model of Lazarus and Folkman (1984).

Other studies with this same theme should be carried out, expanding the number of participants and varying the sample to different Brazilian cities. In addition, a longitudinal study would be interesting to follow if there is a variation of the findings at different moments of life.

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