

Courage as a Moderator of the Biochemical Stress Response in Military Nursing Students

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ABSTRACT

This study examined the role of courage as a moderator of the biochemical stress response in military nursing students. Data were collected from 79 cadets enrolled in the program. The Perceived Stress Scale, the Virtues and Strengths Inventory, and a hair cortisol measurement were used to assess subjective stress, courage, and the biochemical stress response, respectively. To study the moderation effect, a multiple regression model was constructed, including perceived stress, courage, and their interaction as predictors of the biochemical stress response. The results showed that courage had a direct effect on the biochemical stress response, reducing cortisol levels. It was also found that courage moderated the effect of perceived stress on the biochemical stress response. As courage increased, the effect of perceived stress on the biochemical stress response also increased. These findings suggest that courage can act as a protective factor, attenuating the effects of perceived stress on the biochemical stress response in military nursing students. However, it is important to consider that courage may have a differential effect depending on the context and individual perception of stress. These results have implications for the development of interventions that strengthen courage as a coping strategy for stress in this specific population. Further research is recommended to better understand the underlying mechanisms and conditions in which courage can influence the stress response in military nursing students.

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INTRODUCTION

Stress, a physiological and psychological response, has significant implications for individuals' well-being (Lazarus & Folkman, 1984; O'Connor et al., 2021; Turner et al., 2020) [1-3]. Extensive research has examined the health repercussions of stress, consistently demonstrating that it increases the risk of chronic diseases (Cohen et al., 1991; Knight et al., 2021; O'Connor et al., 2021; Yang et al., 2021) [3-6]. This risk is particularly relevant when it comes to military nursing students, who face high levels of stress due to the rigorous academic demands and physical challenges inherent in a military career (Dalvand et al., 2017) [7].

Subjective stress, also referred to as perceived stress, encompasses an individual's assessment of the intensity and nature of chronic stress experienced (Chan & La Greca, 2020; Cohen et al., 1991; Schneider et al., 2020) [5,8,9]. This concept provides valuable insights into how individuals perceive and cope with chronic stressors (Al-Sowygh, 2013) [10]. Furthermore, research has established a link between perceived stress and the biochemical stress response, as measured by hair cortisol levels (Ibar et al., 2021; Psarraki et al., 2021) [11,12].

Cortisol is a hormone produced by the adrenal glands in response to stress (Stalder et al., 2017) [13]. Hair cortisol levels reflect the amount of cortisol produced in the body over a longer period in comparison with cortisol measurement in saliva or blood (Chávez Parillo & Peralta Gómez, 2019; Wright et al., 2015) [14,15]. Previous research has used hair cortisol as a reliable biomarker of chronic stress exposure and its relationship to the physiological stress response (Iob & Steptoe, 2019; Noushad et al., 2021) [16,17].

Character strengths can act as protective factors or moderators of stress in different populations (Karaman et al., 2019; Umucu et al., 2021) [18,19]. They are positive traits that form part of one's identity and, when expressed, lead to positive outcomes for both oneself and others, contributing to the collective good (Niemic, 2020) [20]. Furthermore, these traits are valued across cultures and they generally remain stable over time (Peterson et al.,

2004) [21]. Character strengths serve as crucial influencers that help us embrace positivity and cope with difficulties (Gander et al., 2022; Peterson et al., 2004) [21,22].

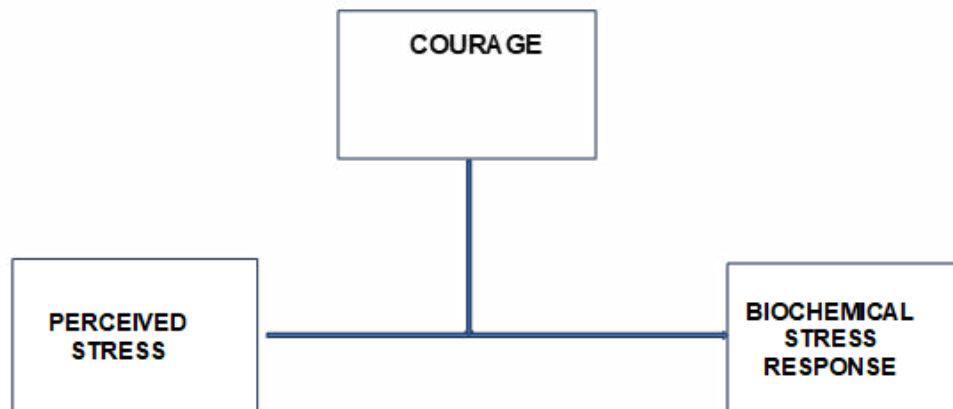
The Values in Action (VIA) Classification of the 24 character strengths, which are grouped under six core virtues (Peterson et al., 2004) [21], has been one of the most significant contributions of Positive Psychology. It has paved the way for the growing research on the benefits of character strengths for individuals' mental health, with courage emerging as a central factor for protection against the detrimental effects of stress (Liu & Wang, 2021) [23]. Peterson and Seligman (2004) [21] define the strength of courage as the ability to act and face threats, challenges, and difficulties with determination and bravery. This strength involves the willingness to take risks, stand firm in adversity, and persevere despite obstacles. In stressful contexts, courage can play a crucial role in mitigating the negative effects of stress and promoting better adaptation and resilience. Several studies have demonstrated that courage reduces the negative effects of stress on life satisfaction among university students (Weber et al., 2013) [24]. Furthermore, it has been found that courage acts as a protective factor against burnout among nursing professionals exposed to work-related stress (Mubarak et al., 2021) [25].

In the context of military training, courage can play a crucial role in mitigating the negative effects of stress and promoting better adaptation and resilience among cadets. The Military Nursing Program involves high levels of stress due to academic demands and specific professional requirements, such as interventions in areas of armed conflict or disasters (Firouzkouhi et al., 2021) [26].

Therefore, this study aimed to examine the role of courage as a moderating variable in the biochemical stress response among military nursing students (see Figure 1). We hypothesized that courage would act as a moderator, attenuating the impact of perceived stress on the biochemical stress response, as measured by hair cortisol levels.

Figure 1

Moderation model between perceived stress, courage, and the biochemical stress response.



Note: Figure 1 illustrates how courage serves as a moderating factor in the connection between perceived stress and the biochemical stress response. This figure helps us understand how courage influences the relationship between an individual's perception of stress and his or her physiological stress response.

METHODOLOGY

Design

The design of this study was cross-sectional correlational.

Participants

A deliberate sample comprising 79 military cadets was meticulously selected from an available pool of 88, enrolled in a Nursing Bachelor's program at a military institution in El Palomar, Buenos Aires Province, Argentina. This selection strategy was non-probabilistic, purposefully designed to capture a representative cross-section of the broader population of military nursing students in Argentina, spanning various academic years and encompassing both genders. To ensure the statistical robustness and reliability of the moderation analysis, a power analysis was conducted prior to the research. This analysis aimed to determine the minimum sample size required to achieve a power level of 80% at a significance level of 0.05, with the objective of detecting a moderate effect size ($f^2 = 0.15$) within the multiple regression framework. The results indicated a requirement for at least 75 participants, affirming the selection of 79 cadets as both adequate and justifiable. Those students who were on sick leave did not participate in the study. The sample included cadets attending all years of the 4-year program, as follows: 25.3% of them were first-year cadets, 19.0% were second-year cadets, 29.1% were third-year cadets, and 26.6% were fourth-year cadets. The

age of the cadets ranged from a minimum of 18 years to a maximum of 28 years, with an average age of 22.76 years. The sample consisted of 40.5% male and 59.5% female cadets, demonstrating a balanced representation of both genders within the sample. Regarding marital status, most cadets (59.5%) were single, followed by those in a dating relationship (30.4%), and a small percentage (10.1%) who were married. As for the place of residence, 12.7% of the cadets lived in the Autonomous City of Buenos Aires, 73.4% resided in the Greater Buenos Aires area, while 13.9% came from other areas outside this region.

Procedure

Initially, contact was established with the management of the military educational institution to organize and plan fieldwork details and obtain the necessary authorizations. Once permissions were granted, the researchers delivered a brief introductory talk for the cadets, emphasizing the relevance of the study and the importance of providing truthful responses. Additionally, the psychological aspects involved in the evaluation were explained in technical terms. A data collection package was sent to the participants via e-mail, which included a consent form, a sociodemographic questionnaire developed ad hoc, the Inventory of Virtues and Strengths, and the Perceived Stress Scale. Google Forms® was used to collect the data electronically and upload it to a database.

Following the administration of the tests, hair samples were collected to evaluate cortisol levels and biochemical stress response in the cadets. This part of the procedure was particularly challenging as students in military training typically have very short hair as an institutional norm. Specific authorization was requested from the educational authorities to allow students to grow their hair for the three months before collection. Hair samples were taken at the Research Department of the military institution in a specially prepared and sanitized room. The samples were properly collected, preserved, and transported by two licensed biochemistry professionals from the Biochemistry Laboratory of the Faculty of Pharmacy and Biochemistry of the University of Buenos Aires. The participants did not receive any kind of compensation for participating in the study and all of them gave written prior informed consent. The study was approved in advance by the Ethics Committee of the Secretary of Research of the military institution and was performed following the Helsinki Declaration for medical studies in humans.

Instruments and Operationalization of Variables

Sociodemographic Survey

This survey collected sociodemographic data about the participants: age, gender, residence, marital status, and course year.

Inventory of Virtues and Strengths (Cosentino & Solano, 2015) [27]

This instrument briefly assesses the original Values in Action Inventory of Strengths (VIA-IS) developed by Peterson and Seligman (2004) [21]. It consists of 24 bipolar items, with one item statement describing a character strength and the other one its absence. The respondents indicate the extent to which they are described by one of the two proposed statements. Responses are provided on a five-point Likert scale, ranging from 1 (very similar to the first person) to 5 (very similar to the second person). A higher score indicates a greater presence of the strength. The instrument demonstrated high internal consistency (Cronbach's $\alpha = 0.95$), considerable reliability (0.72 at 2 months and 0.68 at 6 months), and acceptable concurrent validity (0.39). In the context of this study, the Inventory of Virtues and Strengths was administered to obtain a courage score from the participants.

Perceived Stress Scale (PSS; Cohen, 1988) [28]

This self-report instrument evaluates the perceived level of stress experienced over the past month. It was developed by Cohen (1988) to assess the individual's self-perceived automatic response to stressors without the need for physiological or laboratory measurements. The PSS has 14 items that ask subjects to rate statements such as "In the past month, how often have you been upset because of something that happened unexpectedly?" and "In the past month, how often have you felt that things were going your way?" Subjects rate the items on a 5-point Likert scale, with higher scores reflecting greater perceived stress. Seven items are reverse-keyed and item scores are summed to obtain the final score. The Spanish version of the PSS has been administered to numerous samples, showing desirable values of reliability (0.81), test-retest reliability (0.73), and convergent validity with other measurement instruments.

Measurement of Hair Cortisol

Hair samples were obtained using scissors, from the posterior vertex as close to the scalp as possible. Considering that hair grows approximately 1 cm per month, 3 cm hair samples are required to assess the scalp hair cortisol levels over the past 3 months. Each sample was stored in a paper envelope at room temperature until it was processed. Subsequently, each sample was weighed, and cortisol was extracted and processed using an automated chemiluminescent method (Immolute 2000 autoanalyzer, Siemens, LA, USA), following the patented procedure developed at the Endocrinology Laboratory of the Faculty of Pharmacy and Biochemistry, University of Buenos Aires. The results were expressed in pg/mg. The reference range for cortisol concentration in hair in healthy individuals with low stress levels is 40–128 pg/mg of hair (Percentile 2.5–Percentile 97.5).

Data Analysis

The Kolmogorov test did not provide evidence to reject the null hypothesis, and therefore, normal data distribution was assumed ($p > 0.05$). Descriptive statistics were conducted for all variables in the analysis. To examine the role of courage as a moderating variable in the relationship between perceived stress and the biochemical stress response, a moderation analysis was conducted using R software (version 4.3.0). The analysis was carried out following the approach for analyzing moderation in regression models (Hayes, 2018) [29].

First, a multiple regression model was constructed, including perceived stress, courage, and their interaction (perceived stress x courage) as predictors of the biochemical stress response. The moderation analysis was performed by calculating product terms of the predictor variables, including the interaction between perceived stress and courage.

Standardized regression coefficients, standard errors, and associated p-values were examined for each predictor to assess their statistical significance. All analyses were performed using R software within its R Studio interface (R

Core Team, 2020), and a significance level of 5% was used. The sjPlot package was used to produce the figures, and the lm() function was used for the moderation analysis.

RESULTS

Table 1 presents the descriptive statistics for all variables analyzed in this study. The average value of the biochemical stress response in the assessed cadet sample was found to be 30.15 pg/mg of hair, which falls well below the reference limit established by the methodology (128 pg/mg of hair). These findings strongly suggest a healthy and normal stress response in the study population.

Table 1: Descriptive statistics for the variables courage, perceived stress, and biochemical stress response.

	M	SD
Cortisol	30.11	5.23
Courage	3.80	.13
Perceived Stress	25.45	7.74

The variable "courage" exhibited an average value of 3.80 (SD = 0.13; range: 0-5), indicating a consistently high level of courage across the participants. Additionally, the mean for "perceived stress" was 25.45 (SD = 7.74; range: 0-56), highlighting the diversity of perceived stress levels within

the sample.

The effect of courage was examined as a moderating variable in the relationship between perceived stress and the biochemical stress response, as measured by hair cortisol. The results are presented in Table 2.

Table 2: Main-Effects and Moderation Model.

	Main Effects		Interaction Effects	
	β	SE	β	SE
Intercept	33.52***	4.78	52.04***	9.78
Perceived Stress	.10	.12	-0.56	0.33
Courage	1.59 *	.78	-6.74**	2.51
Perceived Stress x Courage			0.19*	0.08
	$R^2=.07$		$R^2=.12$	

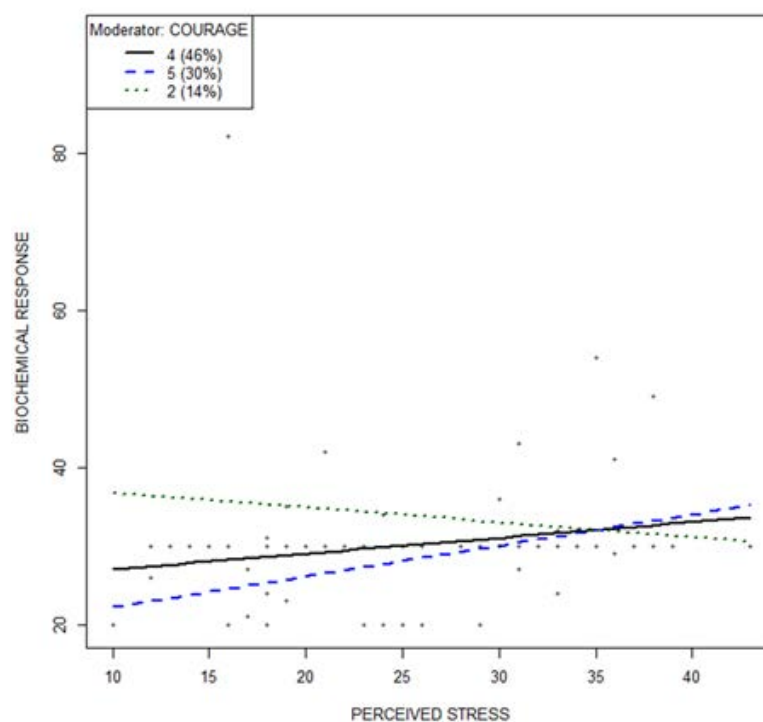
Note: *** p<.001; **p<.01; *p<.05; SE= standard error; R2= coefficient of determination of the model

In the main-effects model, a significant effect of courage on the biochemical stress response was observed when perceived stress was controlled for ($B = -1.59$, $SE = 0.78$, $t(df) = -2.04(76)$, $p < 0.05$). This indicates that for each unit increase in courage, the biochemical stress response tended to decrease by 1.59 units. Higher levels of courage may help mitigate the effects of perceived stress on the biochemical stress response. The results suggest that courage buffers the impact of perceived stress on the biochemical stress

response.

When the moderation model was adjusted, a significant moderation effect of courage was found on the relationship between perceived stress and the biochemical stress response ($B = 0.19$, $SE = 0.08$, $t(df) = 2.15[76]$, $p < 0.05$). This finding suggests that for each unit increase in courage, the effect of perceived stress on the biochemical stress response increased by 0.04 units (see Figure 2).

Figure 2: Courage Moderating the Effect of Perceived Stress on Biochemical Stress Response.



DISCUSSION

Based on the average value of the biochemical stress response in the evaluated cadet sample, which was found to be 30.15 pg/mg of hair, it can be concluded that the participants exhibited healthy and normal stress levels (Gonzalez et al., 2019) [30]. This result suggests that the cadets in this study were effectively managing and coping with stressors, as indicated by their biochemical stress response within the expected range (Ibar et al., 2021) [11].

In this study, apparently contradictory results were observed regarding the role of courage as a stress-protective factor in military nursing students. On the one hand, the main-effects model showed that courage was associated with a decrease

in the biochemical stress response, indicating a direct and protective effect of this character strength (Akkermans et al., 2018; Magnano et al., 2021) [31,32]. On the other hand, the interaction model revealed that courage moderated the effect of perceived stress, increasing the biochemical stress response (Ginevra et al., 2018) [33].

One possible explanation for this apparent contradiction concerns the way in which military nursing students interpret and experience stress. The stress and coping theory suggests that stress can be perceived as a threat or a challenge (Lazarus & Folkman, 1984) [1]. Therefore, courage may have an adaptive effect on moderate or manageable stress situations by helping individuals face and overcome

stressful challenges (Mubarak et al., 2021; Wang et al., 2022) [25,34]. In this context, courage can act as a personal strength that drives individuals to adopt effective coping strategies and maintain a positive attitude towards stress demands (Lazarus & Folkman, 1984) [1]. This ability to cope with stressful challenges may be reflected in a reduced biochemical stress response (Alarcon et al., 2013) [35]. However, it is important to note that when the perceived stress level is high and overwhelming, courage may have a contrasting effect (Liu & Wang, 2021) [23]. In extreme stress situations, courage can lead to increased involvement and exposure to the stressor, which in turn can trigger a more intense physiological response. Therefore, how a stressful situation is perceived, whether as a threat or a challenge, may also influence the stress response (Folkman & Lazarus, 1988) [1].

In this sense, the results suggest that courage acts differentially depending on the context and the individual perception of stress. It is important to consider that military nursing students face unique stressful situations related to their training and the context in which they will practice their profession. Therefore, courage may play a complex and multifaceted role in how these students experience and respond to stress. Further research exploring the underlying mechanisms and conditions in which courage can act as a stress-protective or stress-amplifying factor in this specific population would be beneficial. This would contribute to the development of more personalized and effective intervention strategies to promote the well-being and academic success of military nursing students (Ginevra et al., 2018; Magnano et al., 2021; Platania et al., 2023) [32,33,36].

Concerted efforts were made to minimize various forms of bias in this study. A diverse and representative sample was employed to mitigate selection bias and ensure broader generalizability of the findings. Additionally, the research team adhered to rigorous data collection and analysis protocols to reduce researcher bias (Podsakoff et al., 2012) [37]. Despite these efforts, it is important to acknowledge that some degree of bias may exist due to factors such as self-reporting and the inherent subjectivity in assessing stress levels and courage. In addition, the measures used in this study were based solely on self-report questions, where response bias (e.g., social desirability bias and the tendency

to respond randomly to items) could be of special concern (Latkin et al., 2017) [38]. An attempt was made to reduce the risk of response bias by proposing the task of answering the questionnaires as entirely voluntary and by informing participants in advance that the data collection would be anonymous. While these steps were taken to address potential sources of bias, it is essential to recognize that the complete elimination of bias presents a formidable challenge in any research study. Consequently, further investigations in this field are encouraged to explore alternative data collection methods, including physiological assessments, to complement self-report measures and contribute to a more comprehensive understanding of stress responses and courage (Al'Absi, 2011) [39].

The research was conducted in strict adherence to ethical principles and guidelines. All participants provided informed consent, and our study was reviewed and approved by the relevant ethics committee of the National Defense University. We placed the utmost importance on maintaining participants' confidentiality and safeguarding their well-being throughout the study. We were committed to transparency and ethical conduct in all stages of our research (Shrestha, & Dunn, 2020; World Medical Association, 2013) [40,41].

Several limitations of our study should be considered. Firstly, being cross-sectional, this study cannot determine causal relationships between perceived stress, courage, and the biochemical stress response (Cohen et al., 2007) [42]. Future studies should employ a longitudinal design to examine the moderating effect of courage. Secondly, the data may have involved a degree of subjectivity because self-report measures were used. Objective methods should be employed in the future (Kirschbaum et al., 1993) [43]. Lastly, we considered courage as a specific strength rather than focusing on strengths globally or virtues as a set of strengths. Although using specific strengths as study variables has advantages, the effects of virtues or a global set of strengths should be explored in future studies.

To conclude, we would like to underscore the contributions of the current article. It is well-known that the shortage of nursing personnel, particularly military nurses, is a global concern (Peters, 2023; Tamata & Mohammadnezhad, 2023) [44,45]. One of the causes of this shortage is the stressful nature of this profession. Military nursing students are

exposed to various stressors during clinical practice, which may jeopardize their career retention. Therefore, we believe that this study provides valuable information about the mediating role of courage in the response to perceived stress among military nursing students. By developing interventions aimed at strengthening this character strength in this population, we may better train these students for their professional lives. Similarly, by equipping them with educational tools to face the challenges of military healthcare, we may promote greater retention in their profession.

CONCLUSIONS

This study explored the role of courage in moderating the biochemical stress response among military nursing students, uncovering that courage can serve both as a protective and an amplifying factor under varying perceptions and contexts of stress. Our findings reveal that courage directly influences the biochemical stress response, notably reducing cortisol levels, thus suggesting its potential as a protective mechanism against the adverse effects of perceived stress. Moreover, the moderation analysis indicates that as courage levels increase, so does its capacity to modulate the impact of perceived stress on cortisol production, underscoring the complexity of courage's role in stress response.

These insights underscore the importance of context and individual stress perception in determining the function of courage as either a buffer or an intensifier of stress responses. Such dual functionality of courage highlights its significance in the coping repertoire of military nursing students facing unique stressors, suggesting the potential for tailored interventions that enhance courage as a coping strategy. However, the observed variability in courage's effects also calls for a cautious approach, advocating for further research to delineate the conditions under which courage most effectively serves as a protective factor.

Ultimately, this study contributes to the broader understanding of psychological traits' impact on physiological stress responses, particularly within high-demand settings like military training. By illuminating the protective and complex role of courage, our research paves the way for developing more nuanced and effective stress management strategies, tailored to the unique needs and

experiences of military nursing students.

Credit authorship contribution statement

All authors should have made substantial contributions to all of the following: **Azzara S:** the conception and design of the study, acquisition of data, analysis and interpretation of data, drafting the article, final approval of the version to be submitted. **Grinhauz A:** acquisition of data, analysis and interpretation of data, drafting the article or revising it critically for important intellectual content, final approval of the version to be submitted. **Gonzalez D:** acquisition of data, analysis and interpretation of data, drafting the article or revising it critically for important intellectual content, final approval of the version to be submitted. **Fortuna F:** analysis and interpretation of data, revising it critically for important intellectual content, final approval of the version to be submitted. **Bravo M:** revising it critically for important intellectual content, final approval of the version to be submitted. **Fabre B:** acquisition of data, analysis and interpretation of data, drafting the article or revising it critically for important intellectual content, final approval of the version to be submitted.

DECLARATION OF INTERESTS

The authors of this manuscript declare the following: There are no financial or personal interests, from any of the authors, that could have inappropriately influenced our work. Therefore, we confirm the absence of any conflicts of interest associated with this manuscript.

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