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| ORIGINAL

Prevalence of burnout by social demographic factors and salivary biomarkers through Fourier transform infrared spectroscopy in military police officers of the São Paulo health care team who worked during Covid-19

Análise de biomarcadores salivares, através da espectroscopia de infravermelho por transformada de Fourier, como ferramenta de diagnóstico de burnout em policiais militares do quadro de saúde de São Paulo que atuaram na pandemia do Covid-19, segundo indicadores sociodemográficos

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ABSTRACT

Objective: Study the prevalence of burnout and the salivary biomarkers in military police officers in the São Paulo health-care team who worked during the Covid-19 pandemic in Brazil. **Method**: An observational cross-sectional study was conducted in a sample of 104 participants distinguished by age, skin color, gender, military rank, function performed, length of service, use of medications, smoking, alcohol consumption, and income. The analysis of the social demographic data collected used an adapted Maslach Burnout Inventory and saliva examination through Fourier transform infrared spectroscopy. The statistical tests of chi-square, PLS-DA, and hypothesis were fixed at the 95% confidence. **Results**: The social demographic indicators presented statistical association with burnout, with chi-square 62.72 ($p<0.05$). The prevalence of burnout (80.77%) and risk of development (19.23%) were observed. The presence of biomarkers in saliva (amide, genetic fragments and polysaccharides) in those experiencing burnout aligned with current literature. **Conclusion**: Of the total sample, 80.77% had burnout and 19.23% risk of developing the disease. Young white women, in the role of health assistants, with median income between 3 and 6 times the minimum wage and with less than 10 years of service`s length had the highest prevalence of burnout in relation to their peers. There was an association of social demographic indicators with measured stress levels. Salivary biomarkers were also associated with stress in the initial phase of burnout. There is a pressing need for further studies, aiming to support greater knowledge for this population researched.

Indexing terms: Covid-19. Burnout, psychological. Mental health.

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RESUMO

***Objetivo**: Mensurar a prevalência de burnout e de biomarcadores salivares em policiais militares do quadro de saúde de São Paulo que atuaram frente à pandemia do Covid-19. **Métodos**: Realizado estudo observacional com corte transversal em amostra de 104 participantes estratificado por idade, cor da pele, gênero, patente militar, função desempenhada, tempo de serviço, uso de medicamentos, tabagismo, etilismo e renda econômica. A apuração dos dados sociodemográficos coletados utilizou o inventário de burnout de Maslach- adaptado e exame da saliva, através da espectroscopia de infravermelho por transformada de Fourier. Os testes estatísticos de qui-quadrado, de PLS-DA e de hipótese foram fixados em IC=95%. **Resultados**: Quando em análise conjunta, os indicadores sociodemográficos apresentaram associação estatística com burnout, pelo p-valor de 62,72. Do total da amostra 80,77% apresentaram burnout e 19,23% apresentaram risco de desenvolvimento. Os testes salivares indicaram a presença de biomarcadores (amida, fragmentos genéticos e polissacarídeos) que reforçam os parâmetros validados de diagnóstico precoce para burnout. **Conclusões**: Do total da amostra estudada, 80,77% apresentaram burnout e 19,23% risco de desenvolvimento da doença. Mulheres brancas, entre 30 a 40 anos, auxiliares de saúde, com mediana entre 03 e 06 salários mínimos e com menos de 10 anos de serviço apresentaram as prevalências mais altas do burnout quando comparados aos seus pares durante o enfrentamento do Covid-19. Houve associação dos indicadores sociodemográficos em sua totalidade em relação aos níveis mensurados de estresse. Biomarcadores salivares apresentaram associação com estresse na fase inicial.*

***Termos de indexação**: Covid-19. Esgotamento psicológico. Saúde mental.*

INTRODUCTION

In 2020 by compulsory notification of infectious diseases, an increase in cases of a respiratory manifestation by viral origin, identified at the end of 2019, began to be reported [1,2]. Covid-19 was reported being highly transmissible and responsible to cause severe acute respiratory syndrome [1,2]. Identified in the province of Wuhan in China, probably associated with the primary reservoir in bats, it adapted to human-to-human transmission, quickly triggering a pandemic, which had generated challenge in the health systems policies with unprecedented global effort, surveillance and welfare priorities [2].

Access to health care and social services capable of providing treatment and support has been priority, challenging the politic on universal access and social inequality. The burden of mental disorders continues to grow, with significant health impacts in social, human rights and economic consequences on a global scale [1].

According to the guidelines of the Pan American Health Organization (2021) [1], health professionals were considered fundamental in response to the pandemic and were among the most vulnerable to the impacts of infection and mental health disorders due to their professional exposure. From this perspective, validating the opportunity for an early diagnosis of mental illness on health work has become a desirable tool.

In countries affected by social vulnerability, conflicts and violence, the number of people with mental health disorders represented 22.1%, with a direct impact on risk groups like women and children who experienced violence, soldiers returning from war, migrants and refugees because of conflicts, poverty and unemployment [3].

The economic burden for individual, families and social welfare attributed to mental health disorders was observed in 30% among morbidities and 10% of general mortality rates. The impact in 2020, due depression and anxiety, damaged the global economy in $1 trillion a year on loss productivity. Mental and neurological diseases and the use of toxic substances impacted the world economy in losses between 2.5 and 8.5 trillion dollars, with a projection of a doubling this deficit in the next decade [4].

The social demographic study with 986 health workers in Bangkok, who approached patients admitted to the ICU with Covid-19, between May and June 2021 [5], indicated, through the Maslach inventory [6], that 16.3% had high level of emotional exhaustion, 16% of depersonalization and 53.5% of low professional achievement. These conditions measured the presence of burnout in its three levels of severity and commitment.

Among the stressful professions, military police officers, due to the nature of their activity are vulnerable to this situation [7] and early diagnosis favors the reception of these professionals, as well as improving performance and meeting social demands. Corroborating this situation is the literature that established military police officers as a high risk group for mental disorders, with emphasis on the burnout syndrome [8-10].

In the context of mental health disorder, the opportunity for an early, validated, efficient and quick diagnosis of emotional issues is a valuable tool for public health policies and expresses the ethical and social values attributed to the opportunity to expand access, equality and equity. Among the opportunities for diagnosis, the option for biomarkers in saliva has shown promising results in the literature [11,12].

The present report studied the prevalence of burnout and the salivary biomarkers in military police officers in the São Paulo health-care team who worked during the Covid-19 pandemic in Brazil.

METHODS

An observational cross-sectional study conducted in a sample of 104 participants distinguished by age, skin color, gender, military rank, function performed, length of service, use of medications, smoking, alcohol consumption, and income. The analysis of the social demographic data collected used an adapted Maslach Burnout Inventory and saliva examination through Fourier transform infrared spectroscopy. The statistical tests of chi-square, PLS-DA, and hypothesis were fixed at the 95% confidence.

The Research Ethics Committee by Universidade Paulista was registered by the number 37758920.9.1001.5512 in October 30, 2020 and have approved this work.

For inclusion criteria in this research protocol, medical history information obtained by annual health inspection was considered and for exclusion criteria chewing gum right before saliva collection, tobacco, alcohol, use of steroidal medications and other beverages up to one hour before collection, with the exception of water.

Burnout was categorized into the risk occurrence stage; initial form, representative of emotional exhaustion, lack of energy, feelings of exhaustion, frustration and tension; intermediate stage, characterized by depersonalization, professional insensitivity towards clients, colleagues and managers; and advanced stage, characterized by low personal fulfillment at work, self-deprecation, devaluation and isolation [13,14].

The saliva collection and analysis technique [15] was conducted in October 2020, between 9AM to 10AM respecting the lowest circadian fluctuation, after mouthwashing with mineral water and with the participants relaxed. The expectoration method [16] was used, with immediate storage of 3 ml of saliva in a 15 ml transparent polypropylene tube for sterile centrifugation (FirstlabTM). Each tube was identified in correspondence to the order of the Maslach research survey data, by number, name and date, stored in freezer at 0.4 ºF (-18ºC), controlled by a thermostat.

For analysis, after thawing out in the environment, three drops of 1 µL of each sample were collected, through single-channel micro pipetting of variable volume (Boeco GermanyTM) coupled to the tip without filter 0.1-10 µL transparent Gilson type (OlenTM) and deposited in a platinum device, respecting the transcribed numbering of the collection tube. The drops were dehydrated in the environment to be transported for reading in the laboratory, where they were kept in an freezer [17-19].

Sociodemographic data and sample consistency were adjusted using the Epi-Info TM package. The analysis was descriptive and the associations between stress levels and sociodemographic categories were tested by chi-square using the statistical package Bio Estat 5.3 TM [20].

The non-parametric chi-square test was selected for linking nominal variables and their independence, measured by the frequency obtained, for each sociodemographic category observed in relation to the expected frequency, defined

by the precision set at a significance fixed at 95% confidence. The tabulated chi-square values, determined by the degrees of freedom and the p-value, were conditioned by the upper chi-square value of the right one-tailed curve (established by the consistency check) measured using the contingency tables.

The null hypothesis (H0) considered that association between the frequencies observed by sociodemographic category and the level of stress intensity were not statistically significant.

The alternative hypothesis (H1) considered that observed frequencies were different from those expected, which statistically validates the association between each sociodemographic category tested and the level of intensity measured by stress.

Before observation, the collected material was submitted to optical microscopy for proper selection of the best saliva fragment for biomarker research [11].

For analysis of salivary spectroscopy, statistical data integrity checking tests were considered; imputation on null values (replaced by 1/5 of the smallest positive value); normalization of the curve by adjusting the mean in relation to the fixation of the standard deviations and application of statistical analysis of univariate data (One Way-ANOVA and post hoc).

For exploratory data analysis and correlation with stress values, machine learning, partially discriminated multivariate regression (PLS-DA) tools were applied, which corrected the peak correlation values of spectroscopy waves [21,22] through the statistical program R version 4.2.0 [23].

RESULTS

The prevalence results determined in the socio demographic factors are shown in tables 1 and 2. The chi-square test calculated for the sample (138.56) was higher than the tabulated one (9.49) and p-value < 0.0001, established for the 4 degrees of freedom fixed for an alpha of 0.05, rejected H0, statistically validating the association.

Table 1. Chi-square test in the association between category and prevalence of burnout in 104 military police officers from the PMESP health team who worked with Covid-19 patients in 2020.

Burnout category	Observed	Expected	o-e[1]	d [1,2]	d²/f expected
No Burnout	0	20,8	-20,8	432,64	20,8
Risk of occurrence	20	20,8	0,8	0,64	0
Initial Stage	66	20,8	-45,2	2043	98,22
Intermediate Stage	17	20,8	-3,8	14,44	0,69
Advanced Stage	1	20,8	-19,8	392,04	18,85
TOTAL	104	104			138,56

Footnotes: 1-o=observed frequency. e= expected frequency. d=difference. 2.- $d^2 = (Iof\text{-}efI)^2$.

The age of the sample ranged from 26 to 56 years, the mean was 40.9 years (s = 9.2 years), and 66.4% were younger than 45 years.

The highest prevalence of burnout in the sample occurred between 30 and 40 years of age, with 28.85% represented by the disease in the initial phase, followed by 19.23% in this same phase, in ages ranging from 46 to 55 years.

Table 2. Survey results by social demographic category and burnout stages in 104 military police officers from the PMESP health team who worked with Covid-19 patients in 2020.

Social Demographic	Category	Risk of Occurrence	Initial Stage	Intermediate Stage	Advanced Stage
Age	26-30	2	7	1	1
	31-35	3	15	4	0
	36-40	3	15	3	0
	41-45	4	8	4	0
	46-50	4	10	1	0
	51-55	2	10	4	0
	56-60	2	1	0	0
Skin Color	white	17	43	13	1
	non white	3	23	4	0
Gender	female	7	35	6	0
	male	13	31	11	1
Military Rank	Private	2	10	1	0
	Corporal	4	10	4	0
	Sergeant	4	16	5	0
	Warrant Officer	0	1	0	0
	1st Lieutenant	6	19	5	1
	Capitain	2	8	2	0
	Major	2	1	0	0
	Lieutenant Colonel	0	1	0	0
	01 a 05	1	8	1	1
	06 a 10	4	18	3	0
Lenght of Service in years	11 a 15	2	9	4	0
	16 a 20	5	11	2	0
	21 a 25	5	10	4	0
	26 a 30	1	7	3	0
	+ 30	2	3	0	0
	>3	2	10	1	0
Income (MW)[1]	3—6	8	27	9	0
	6—9	8	27	7	1
	>9	2	2	0	0

Note: Footnote 1- MW-Minimum wage.

The ages with the lowest prevalence of burnout were observed in the range between 26 and 30 years and one representative in the advanced stage.

Among white participants, the prevalence of burnout was 54.81%, distributed among 43 participants in the initial phase, 13 in the intermediate phase and 01 in the advanced phase. Among the total non-white skin color, 45.19% had a prevalence of burnout distributed in 23 participants in the initial phase, 04 in the intermediate phase and none in the advanced phase.

In the sample, 46.15% were female participants and 53.85% by males. Women had 33.65% of burnout in the initial phase, 6.73% at risk of developing the disease and 5.77% in the intermediate stage. Men had 28.81% in the initial phase, 12.5% risk of developing burnout and 10.58% in the intermediate phase.

Of the total sample surveyed, 24% of burnout cases were found in first lieutenants, followed by 20.19% in sergeants. Of the total prevalence of burnout, 44.20% were registered in health assistants and 35.58% were registered in officers. The risk of developing burnout was measured at 19.23% equally between officers and health assistants.

Between 01 and 05 years of service, 72.73% of the interviewed presented an initial phase of burnout and 27.7% equally divided in the risk, intermediate and advanced stages. Between 06 and 10 years of service, 72% of respondents had an initial phase of burnout, 16% risk of developing the disease and 12% in the intermediate phase. Between 11 and 15 years of service, 60% of the interviewees presented an initial phase of burnout, 26.67% intermediate and 13.33% in the risk of occurrence stage. Between 16 and 20 years of service, 61.11% of respondents had an initial phase of burnout, 27.78% risk of developing the disease and 11.11% in the intermediate phase. Between 21 and 25 years of service, 52.63% of respondents had an initial phase of burnout, 26.32% risk of developing the disease and 21.05% in the intermediate stage.

Between 26 and 30 years of service, 63.34% of respondents had an initial phase of burnout, 27.27% an intermediate stage and 9.09% a risk of occurrence stage. With more than 30 years of service, 60% of respondents had an initial phase of burnout and 40% were at risk of developing the disease.

From 104 surveyed, 97 police officers responded that they carried out their function exclusively in clinical health activity during the Covid-19 period, which did not allow the application of the chi-square independence test and its association with burnout.

Of the total sample surveyed, 03 participants reported being smokers, with 01 being occasional. Regarding alcoholism, the answer was inconclusive. Due to the low number of participants who responded to this condition, it was not possible to test the association, but the context for analysis of salivary indicators was considered.

The median income was 4.05 minimum wages per month (one minimum waged corresponded by US$ 264 for a 160-hour monthly). The value of US$ 1000 was represented by 11.54% of the sample, based on the reference month of August 2020 [24]. 12.5% of the sample received 2.89 minimum wages. Of the total sample, 13 participants received values lower than 03 minimum wages, 44 participants received between 03 and 06 minimum wages, 43 participants, between 06 and 09 and 04 participants with income greater than 09 minimum wages.

The answers that most influenced the self-perception of stress, triggering the interpretation of burnout were questions 8 (I feel that my salary is disproportionate to the functions I perform), answered by 52.9% as "mostly" or "always". Followed by question 5 (I treat people as if they were my family) answered by 41.4% as 'mostly" or "always" and 9 (I feel that I am a reference for the people I deal with daily) answered by 40.4% as "mostly" or "always".

The answers that least influenced the self-perception of burnout were question 20 (I feel that I no longer believe in the profession I practice), answered by 79.8% as "never" or "rarely". Followed by question 14 (I feel unmotivated to achieve any significant result) answered by 77.9% as "never" or "rarely" and 16 (I have felt more stressed in relation to the people I attend) answered by 67.3 % as "never "or "rarely".

Regarding the spectroscopy, based on the necessary statistical adjustments, it was possible to identify a positive correlation between burnout in the initial phase and spectral peaks, adjusted as shown in figure 1. The red dots represented the features above the threshold (peaks). Changes in p-valueswere log-transformed. The greater the distance from zero, the more significant is the correlation.

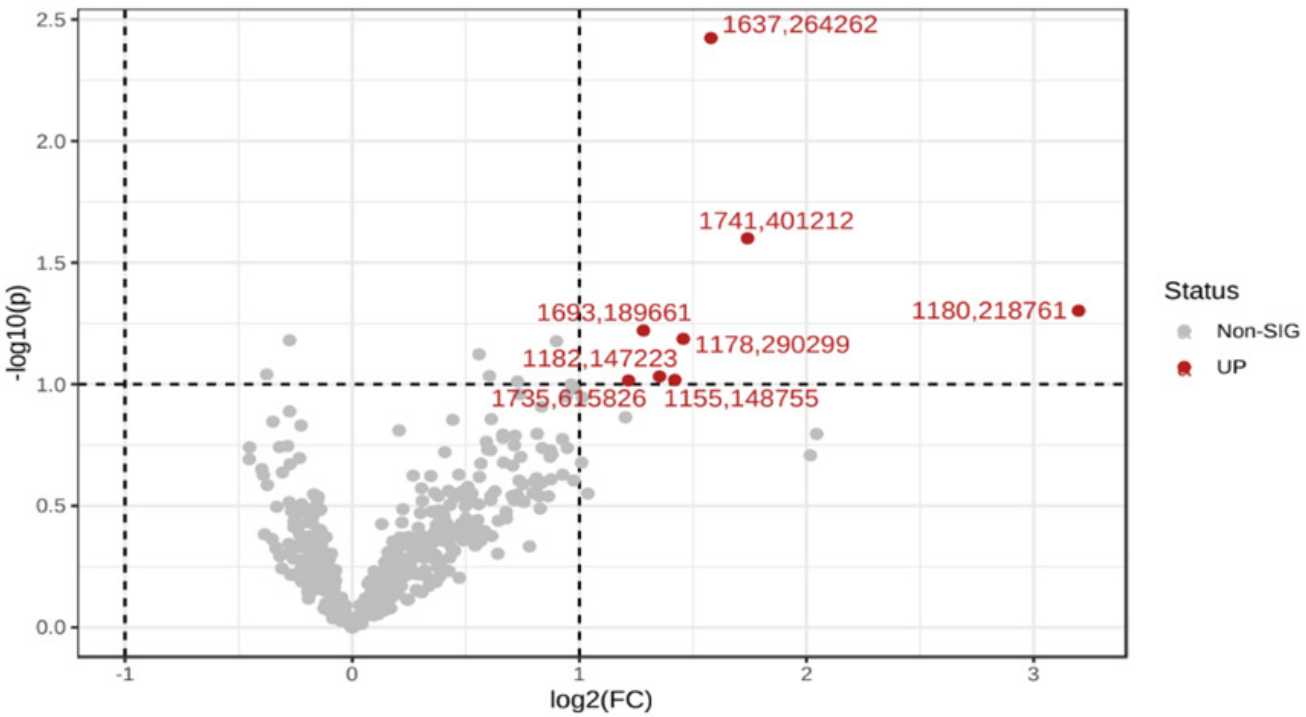

Figure 1. Results by adjusted multivariable analysis in a volcano model on the positive correlation between spectroscopy peaks and stress in military police officers from PMESP health team who worked with patients with Covid-19 in 2020.

Note: Label: Log=logarithm. P= p-valor. FC= Fischer Correction. Non-SIG= non significant data. Up-significant data by upscalling.

Adjusted values allowed the identification of salivary biochemical components related to burnout (figure 2 and table 3).

Table 3. Designation of intensity peak by infrared spectroscopy in saliva collected from 104 military police officers from the PMESP health team who worked with patients with Covid-19 in 2020 [25].

Peak (cm^{-1})	Designation[1]
956.52	Symmetrical elongation of PO_4^{-3}
1178.29	Amida band III
1180.22	Amida band III
1182.15	CH_2
1245.79	PO_2^- asymmetric
1423.2	D (CH_2) (polysaccharides, pectin and cellulose)
1637.26	C=C Uracil, C=O
1643.05	Amida band I (above vibrational stretching C=O)
1693.19	High frequency β-leaf not parallel to band Amida I (remained flat stretch of the band; C=O weakly linked to compound elongation of C-N e N-H.
1741,4	C=O; C=O elongated vibration (Lipids) and elongated vibration of C=O Ester and Phospholipid

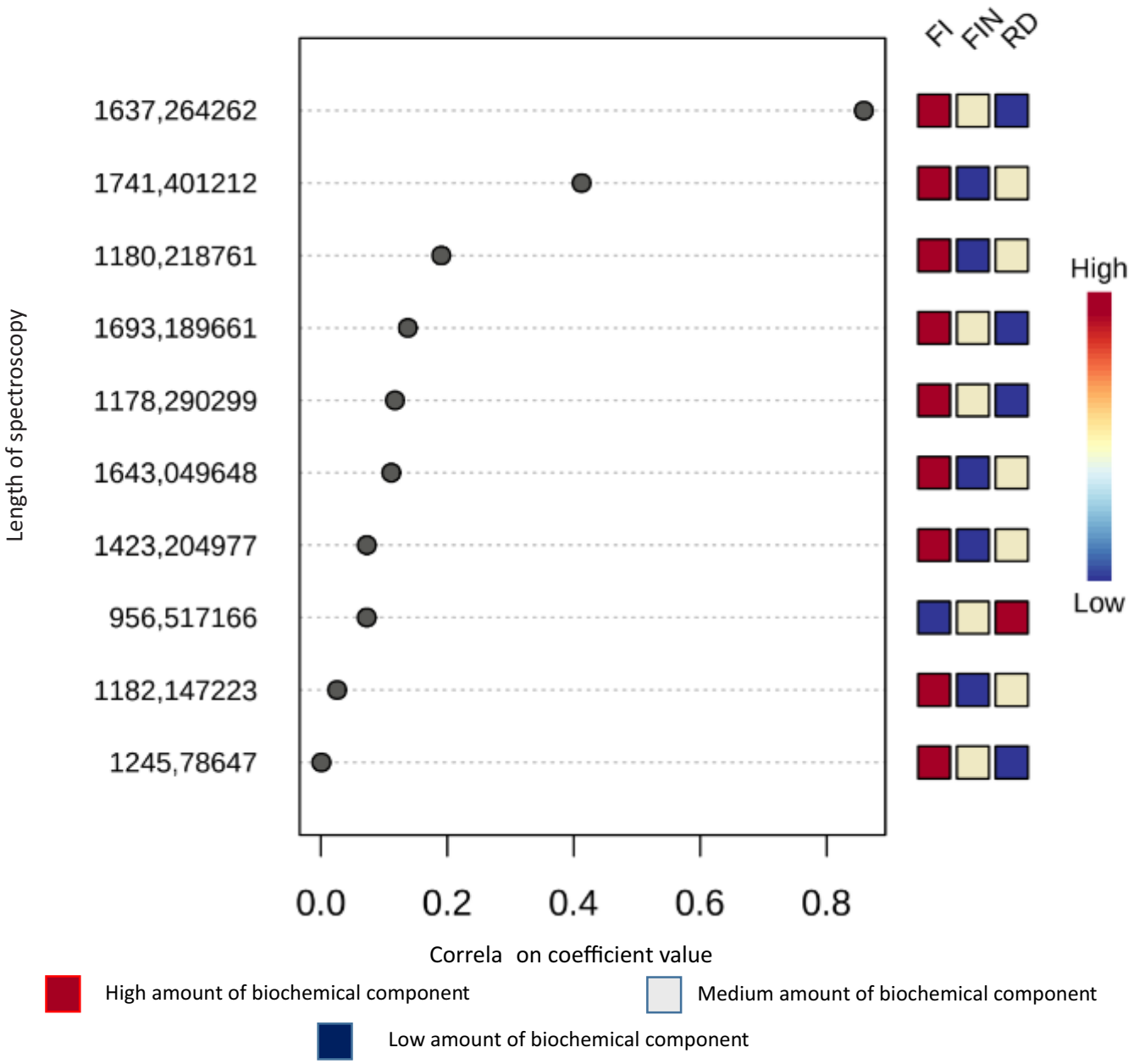

Figure 2. Graphical representation of the spectrum peaks and their correlation associated with the initial, intermediate and burnout risk stages in the saliva collected from 104 military police officers from the PMESP health work team who worked with patients with Covid-19 in 2020, after application of the correlation by machine learning and PLS-DA between 956.52 to 1741.4 cm-1.

Note: FI= Initial Stage. FIN=Intermediate Stage. RD=Risk of Occurrence.

DISCUSSION

No social factor alone was directly associated with stress levels, but when the analysis considered all sociodemographic indicators established for the study with burnout levels, using the calculated chi-square test, H0 was rejected, statistically validating the association.

There was a high concentration of Amide III associated with the initial stage of burnout, which indicated an important finding for complementing the salivary diagnosis, consistent with its founding in the literature [25,26]. Phosphate ions were also suggestive of initial stress risk.

The significant number of sickness health workers can be explained by the circumstances of the actions, in the face of Covid-19 and presented similar results to studies [7,27-29] that used the same investigation tool, despite the different sample sizes suggesting caution in this affirmation.

The high prevalence observed in military personnel supported the point made by reports [7,8,10] who considered the military police profession high vulnerable in the conception of risk groups. It is noteworthy that, to be considered a public health problem, stress must have been related to a common cause, the possibility of public policy intervention and investigation of the non-use of prevention tools on the natural history of diseases and that this conception does not prioritize groups regarding the concept of mental health.

In an approach with health workers in the care of patients with Covid-19 in Paraíba [28] the results found there were statistically similar to the present study, with more than 80% of burnout, but with different age impacts. In the present study, the most prevalent age group was between 31 and 40 years old, different from the study in the State of Paraiba (between 24 and 33 years old).

There was agreement with was pointed out in [30] by the financial trigger attributed to stress. The comparison between this information must consider different sizes samples with different inventories, but the same context of self-perception point, justifying this finding.

The results of the present study indicated that 63.46% of the interviewed, presented the initial stage of burnout, characterized by emotional exhaustion, lack of energy, enthusiasm depletion feeling of resources, frustration and tension. This value was above the 16.3% reported in [5], but similar to that found in similar exposure conditions [27].

Some methodological limitations of the present study must be pointed out. The first lies in the difficulty of defining the burnout outcome based on the self-perception established by subjective values and from the moment of the respondent's response. Data collection using the Maslach index was performed at a different time from saliva collection, which may represent statistical changes that need to be evaluated in new population inference`s studies.

The non-significant findings on habits (smoking and alcoholism) could be explained by the bias of the outcome information from the research. Since the application of the stress test was carried out with the knowledge of the voluntaries that, the analyses of the data, would be conducted by a military researcher, thus possibly contributing to "false-negative" responses for this indicator.

The function-performed factor also did not influence the findings, considering that all health professionals were, at the time of the research, assigned to actions related to Covid-19.

The effect of these potential information biases on the detected prevalence, therefore, cannot be adequately estimated.

It can be said considering the methodological limitations presented that although the associations between stress levels and socioeconomic indicators are complex and imprecise, they indicate how much mental health factors challenge the public health policies.

The correlation of the presence of amide can mean an important finding in relation to the inflammatory context, mainly due to the occurrence of acute stress, as pointed out in the literature [30].

CONCLUSION

Of the total sample studied, 80.77% had burnout and 19.23% were at risk of developing the disease. White women, between 30 and 40 years old, health assistants, with a median between 03 and 06 minimum wages and with less than 10 years of service, had the highest prevalence of burnout when compared to their peers during the confrontation

of COVID-19. There was an association of sociodemographic indicators in their entirety in relation to the measured levels of stress. Salivary biomarkers were associated with stress in the initial phase. There is an urgent need for new studies, aiming to base more knowledge on this researched group.

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Collaborators

MB Arsenian and EM Giovani, field research, data collection, data survey analysis, interpretation, writing the article.

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