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Articles

Psychological stress in nurses assisting Amyotrophic Lateral Sclerosis patients: a statistical analysis based on Non-Parametric Combination test

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Abstract

We aimed to evaluate the psychological, emotional and relational burden of nurses who provide assistance to patients affected by Amyotrophic Lateral Sclerosis (ALS). A survey was conducted by administering a questionnaire, the "Health Professions Stress and Coping Scale", which proposes some potentially stressful work situations. The questionnaire was administered to 105 nurses working in hospitals where there is a ward for patients suffering from ALS. We used the "Non-Parametric Combination Test", a multivariate methodology based on permutation solution, widely applicable in various research contexts. Firstly, we investigated the areas of stress; then, the attention was focused on the different coping strategies adopted by respondent nurses within each stress area. The analyses were stratified according to different confounding factors, in order to control their potential effect. The results show the presence of an average level of stress, regardless of gender and educational status. Furthermore, there are significant differences in stress levels in subjects classified according to the ward in which they operate and a positive correlation between higher stress levels and the number of service years was found. In the future this study could also be of interest to nurses working in wards with potentially stressful situations.

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1. Introduction

Amyotrophic Lateral Sclerosis (ALS) is a neurodegenerative and progressive disease that affects the nerve cells of the brain and spinal cord that allow voluntary muscle movements. Amyotrophic Lateral Sclerosis has an incidence of 1.2-4.0 cases per 100,000 individuals per year, while the increasing prevalence is 6 cases per 100,000 individuals (Gordon, 2013; Mitchell &

Borasio, 2007). The increase in the number of people living with this disease is substantially due to the improvement of palliative care, to the general improvement of the living conditions of the person affected by ALS. There is a preponderance of the disease in males over females (Kiernan et al., 2011). The risk of developing amyotrophic lateral sclerosis is highest between the ages of 50 and 75, suggesting that age may be one of several risk factors (Hardiman et al., 2011). ALS typically progresses slowly and, if well monitored and treated, can allow for an acceptable quality of life. However, the severity can vary greatly from one patient to another, because it depends on the affected muscles, the speed of worsening and the extent of the paralysis. In the individual patient, evolution must and can only be assessed through periodic neurological control, usually every 2-3 months, and through repetition of blood and neurophysiological and neuroradiological tests.

To date, there is still no cure for the resolution of this pathology, in fact, muscle weakness and atrophy extend to other parts of the body, progressively leading to almost total paralysis at different times, culminating, sometimes, in the "Locked -in" in which a fully functioning brain becomes trapped in a completely paralyzed body. Within this dramatic clinical picture, the internal organs, the five senses, the sexual and sphincter functions and the muscles that control eye movements are not compromised. In this context, the role of the nurse, within a multidisciplinary team, is essential in assisting these patients in order to improve their quality of life even in illness. For this reason, nurses have to face very stressful situations, both physically and emotionally, because the excessive workload and the pressing rhythms can negatively influence their psychological sphere, often causing significant emotional distress (Di Nuovo & Narzisi, 2021; Frisone et al., 2021).

Italian healthcare is based on companies with public legal personality endowed with organizational, managerial, technical, administrative, patrimonial and accounting autonomy. As such, they are analyzed as organizations of goods and human capital aimed at satisfying human needs through the production, distribution or consumption of services to customers. Nursing care is a fundamental part of the implementation of outcomes focused on overcoming the pathological situation and on solving the needs of the patients (McKnight et al., 2020). The nurse is the one who takes care of the assistance to the person, but in the case of particular departments it is not only the patient who must be assisted, it is often the entire family unit (Cîrstoveanu et al., 2020; Merlo et al., 2021a). It is not enough to establish a simple empathy, you need to find a dialogue, a relationship that allows the nurse to gather the trust of the patient and his loved ones. In the context of research on stress, a particular construct appears, namely

the "coping mechanism" defined as the set of behavioral and cognitive responses aimed at managing stressful situations. (Rania et al., 2021). The coping response derives first and foremost from the subjective perception of the event deemed more or less stressful depending on the personal and social resources available; it follows that in the face of the same event the individual can activate different coping mechanisms in succession according to their perceived effectiveness (Boateng et al., 2019; Ramlan et al., 2020).

The evaluation of coping mechanisms is essential in order to understand the individual's ability to adapt and react to stressful situations (Merlo et al., 2020). The perception of the intensity of stress is subjective and depends on a series of individual, social and institutional variables. The repetition of stressful situations leads to a high risk of burnout. The effects of this syndrome do not exclusively affect the psychophysical state of the health worker but have repercussions on his work and family environment and can lead to those who suffer from it to carry out their profession in an inappropriate way.

An important contribution is given by Heinemann et al., who defined the burnout syndrome as a syndrome characterized by a series of symptoms involving a severe condition of physical exhaustion due to an imbalance between the demands of work and the individual's ability to satisfy them (Heinemann & Heinemann, 2017). The results of some recent research have highlighted a work environment that is not very stimulating for individual skills as an alternative cause of burnout. The symptomatology is wide and regards both the physiological dimension, among which the most recurrent symptoms are headaches, sleep disturbances, gastrointestinal disorders, shortness of breath and chronic fatigue; both the affective-cognitive dimension such as, for example, anxiety and irritability, altered mood, rigidity of thought, suspiciousness and paranoid ideation, emotional detachment and cynicism and both the behavioral dimension, wanting to consider delays at work, absenteeism, aversion as an example the environment and difficulties in interpersonal relationships with colleagues and patients.

Finally, it appears necessary to place what has been said in a national legislative framework on work and health. In this regard, we consider article 2087 of the Civil Code which states "The entrepreneur is obliged to adopt in the business of the business the measures which, according to the particular nature of the 'physical integrity and moral personality of employees ", and Article 38 of the Constitution:" Workers have the right to provide and ensure adequate means for their life needs in case of accident, illness, invalidity and old age, unemployment involuntary ".

In addition, Legislative Decree 81/08 adopts the definition of health proposed by the World Health Organization, understood as "a state of complete physical, mental, and social well-being, not consisting only in the absence of disease or infirmity". In this perspective, therefore, the protection of workers also against psycho-social risks, as established by article 28 of the same Decree, which states that the employer must provide for the assessment of the occupational risks for the safety and health of workers, including those concerning groups of workers exposed to particular risks, including those related to work-related stress. To address the application problems in relation to what is indicated in Article 28, the Permanent Advisory Commission for Occupational Health and Safety has been entrusted with the task of developing the information necessary for assessing the risk of work-related stress. These indications were approved by the Ministry of Labor and Social Policies on 17 November 2010 and disseminated to the supervisory bodies responsible for health and safety as well as to the entire national territory through the publication of the indications on the institutional website of the Ministry.

The rules on safety in the workplace, including, therefore, those relating to correlated stress, also find application in the health authorities and determine a system of responsibility involving various professional figures who must monitor this risk, prevent it and protect workers (Auteri et al., 2019; Merlo et al., 2021b). In the literature, various methods of analysis of work-related stress have been devised, including the Health Professions Stress and Coping Scale (HPSCS) questionnaire.

1.1 Aims of the study

The present paper aims to analyze, using statistical methodology, the stress level of nurses who care for ALS patients (detected using the HPSCS questionnaire), identifying not only the most affected stress areas, but also the related coping strategies implemented to deal with it.

The paper is structured as follows:

- section 2 describes the HPSCS questionnaire, used in the health field, defining the stress areas and coping strategies and the sample of nurses is presented. In addition, the theoretical assumptions of the NPC methodology are described and an overview of scientific articles with application of NPC methodology in various fields of medical and health research is reported;
- section 3 illustrates and discusses the results of the analyses carried out by NPC test, stratified according to different confounding factors; it contains the tables about the

descriptive statistics and statistical comparisons performed between nurses (grouped according to different variables) within the five stress areas and the four coping strategies;

- sections 4 contain some concluding remarks and reflections.

2. Materials and Methods

2.1. Health Professions Stress and Coping Scale questionnaire

The Health Professions Stress and Coping Scale is a self-assessment questionnaire developed for the measurement of perceived stress and for the description of coping strategies in the health sector (Di Giacomo, 2020; Ripamonti et al., 2006). The questionnaire presents some work situations potentially capable of causing stress; it allows you to simultaneously measure both the level of stress perceived by the health worker in each individual situation, and the coping strategies designed to counteract it.

The HPSCS has two different versions, one for nurses and the other for physicians; in this paper, the version for nurses was considered, since nurses operating in wards dedicated to ALS patients represent our units. This tool proposes 19 situations referring to five areas, created based on specific theoretical criteria and supported by validation analyzes. The tool is used to measure perceived stress and coping strategies related to each of the following five areas:

- Clinical emergency: it refers to situations of high emergency, sudden worsening of the patient's clinical condition, risk or even death of the patient; (item: 2,6,7,8);

- Problematic relationships with patients and family members: it refers to problems inherent in relationships with the patient or with his family, which can hinder the normal performance of work (item: 4,9,15,16,18);

- Personal Attack: it refers to possible situations of friction or unfair behavior that the nurse suffers from colleagues, superiors or patient's family (item: 1,3,5,11);

- Personal devaluation: it refers to situations in which the nurse perceives a negative attitude, on the part of superiors, regarding his requests, suggestions and training needs (item: 10,12,13);

- Organizational contingencies: it refers to situations of unexpected organizational setbacks that prevent the nurse from regularly carrying out his duties or interfere with his private life (item: 14,17,19).

Firstly, the nurse is asked to indicate the stress level for each of the proposed situations, expressing it on a four-point Likert scale (0 = Not at all; 1 = Little; 2 = Quite; 3 = Very);

secondly, he is asked to express, with the same response scale, the frequency with which he resorts to each of the following four coping strategies:

- ***Problem solution***: it refers to the search for solutions to solve problematic situations, using personal resources and experiences;

- Request for social support: it refers to the request for support, advice and help from other people to deal with and solve a difficult situation;

- Emotional distress: it refers to the emotional reaction that the nurse shows when faced with a problem that he cannot adequately manage***.***

- Problem avoidance: it refers to the tendency, on the part of the health worker, to avoid facing the problem, both at cognitive and behavioral level, delegating its solution to others (colleagues or superiors)".

The HPSCS, which is self-filling, also provides for the collection of personal data such as age, gender, educational status and years of service in nursing qualification.

The tool provides for the transformation of raw scores into T scores with mean and standard deviation of 50 and 10, respectively (Ripamonti & Bandieri, 2007).

Stress levels can vary according to a range that identifies an ordinal variable:

T <35: very low

35≤ T <45: low

45≤ T <55: medium

55≤ T 65: high

The scores relating to the **coping strategies**, referred to the five specific areas, express the frequency of use by nurses:

T <35: very rarely;

35 <T <45: little;

45 <T <55: usually;

55 <T 65: very frequently.

In order to evaluate the combined effect of chronological age (C.A.) and years of service in nursing qualification (Y.S.), we estimated a risk index (R.I.) (Abbate et al., 2004). It can be expressed in according to the following formula:

$$R.I. = 1 - \frac{C.A. - Y.S.}{C.A.}$$

This index assumes as least value 0, in absence of risk, and it asymptotically tends to 1 in case of maximum risk. For all nurses we calculated the median value (equal to 0.278) and the mean value (equal to 0.283) of this index; these two values are equivalent (0.28), so no choice between the two position indices was necessary. In this way we realized two classes of exposure risk: 0 ($R.I. \leq 0.28$) denoting low exposure risk, and 1 (> 0.28) denoting high exposure risk. All statistical analyses were performed taking into consideration the belonging of each nurse to one of the two risk classes

2.2. Empirical analysis

In the late 20th and early 21st centuries the interest in statistical sciences applied in medical field was undeniably increased. This has driven the application of various statistical methodologies to analyze several medical cases. Below, starting from a comparison of different approaches, we are going to analyze the one used in our paper; underlining the advantages that, in our opinion, derive from it. Randomized clinical trials and observational studies are medical research tools used to evaluate the association between exposure to one or more factors (for example, treatment) and the outcomes like quality of life or death. Based on this, randomized clinical trials represent the most important methodology, as they provide a rigorous approach to the problem right from the accurate definition of the study protocol for the random assignment of units / subjects to treatments. The observational study differs from the randomized clinical trial mainly because the investigator does not check the conditions of the study (Agovino et al., 2018; Brombin et al., 2013; Rosenbaum, 2005). It is therefore important to identify statistical-methodological paths that are specific to the observational context. The presence of confounding factors such as the variable response to the same or different treatments when non – random assignment of units is used for the comparison of different groups. If the confounding factors are not considered, they can lead to a misinterpretation of the treatment-response, especially considering that often in clinical studies there is no real control / reference sample

group available (Brombin & Di Serio, 2016). Therefore, is important to identify statistical-methodological paths that are specific to the observational context.

In this scenario the multivariate NPC permutation tests represent a validated and effective solution (Arboretti et al., 2015). It is known that parametric methods use a very huge number of assumptions compared to non-parametric ones (Caughey et al., 2017; Corder & Foreman, 2009). If additional assumptions are correct, parametric methods can give accurate and precise results but when they are incorrect, parametric methods sometimes could lead to misleading results. For this reason, parametric methods are often considered not very robust, or not exempt from the negative influence of violations of the assumptions to which they are referred.

Classics articles indicate the growing interest in permutation inference, due in part to the increased availability of the computer resources needed to enumerate permutation distributions and in part to increased interest in experiments (Bowers et al., 2013; Keele et al., 2017; Glyn & Ichino, 2014). In order to decide whether to reject a null hypothesis or not, in permutation inference, the observed value of a test statistic and its permutation distribution under the null hypothesis must be compared. It is usually possible to simulate, with arbitrary accuracy, the null distribution in two ways:

- by calculating it analytically;
- by shuffling many times the group labels of units and computing the value of the test statistic in each permutation.

Permutations are exclusively acceptable among units that are exchangeable under the null hypothesis. Assuming that test statistics are expected to be large in the alternative, the permutation p-value is the probability across permutations of observing a value of the test statistic at least as extreme as the one actually observed. The probability of rejecting a true null hypothesis that is no greater than the p-value indicates that permutation tests are exact independently from the probability distribution that generated the data (Giacalone et al., 2018a). An important clarification must be made regarding the assumption of exchangeability: the responses of units in different groups are exchangeable under the null hypothesis. If a cluster of observations joint distribution is invariant under permutation of the order of the observations, it is said to be exchangeable. Independent and identical distribution is a sufficient but not a necessary condition for exchangeability.

In the field of permutation tests, exchangeability is typically justified under either a "population model" or a "randomization model" (Lehmann & Romano, 2006). Under the population model,

observations are conceived as random samples from one or more populations. Under the null hypothesis that the (unknown) population distributions are identical, observations in distinct groups are exchangeable, and thus permutation tests may be used to test null hypotheses of distributional equality between groups (Pitman, 1937). Permutation tests are more commonly motivated under a randomization model, in which exchangeability is justified by random assignment of treatment rather than random sampling (Fisher, 1935; Rosenbaum, 2005). The randomization model lends itself to application to randomized controlled experiments. Considering natural experiments like Mendelian experiments in which the randomization is not controlled by the researcher, as well as observational studies in which treatment can be considered "as if" randomly assigned (Dunning, 2012; Ho & Imai, 2006). In many observational studies, stratification or matching can also be used to create subsets of exchangeable observations. To respect the restricted nature of the putative randomization, permutation inference must be based on permutations within exchangeable subsets (Rosenbaum, 2005). Considering that one of the objectives of statistical researchers in the medical field is to establish what are the advantages deriving from the use of non-parametric tests compared to parametric tests and according to what has been said so far, it is necessary to add:

1. Classical procedures for detecting differences are those in which, under the population model of inference, the test statistic is referred to the t- or F-distributions. The validity of statistical inferences from these tests depends on several assumptions. The first of these is that the experimental groups have been composed by taking random samples from defined populations. The statistical inferences then apply to the sampled populations to compare permutation tests (Arboretti et al., 2020; Ludbrook & Dudley, 1998).

2. In medical research this sampling process is rarely pursued. Alternatively, samples are usually acquired by non-random selection, and are then divided by randomization into experimental groups. This being the case, it is theoretically invalid to use the classical t- or F-tests to analyze the experimental results [31]. In particular, we cite some application in biomedical context (Giacalone et al., 2018a, 2018b; Zirilli & Alibrandi, 2011, 2012).

3. The legitimacy of inferences from the classical tests, obviously, depends on other assumptions, such as that the sampled populations are normal in form and of equal variance. When group sizes are small, it is difficult to be certain that these assumptions are met. Their infringement, especially if the groups are unequal in size, can lead to serious statistical errors (Sprent & Smeeton, 2016).

4. Exact permutation tests are used to make statistical inferences under the randomization model. This only applies to results of experiments performed. By permuting the statistic of interest, the probability is determined in a such of manner that the observed difference or a more extreme one could have occurred by chance (Pesarin, 2011).

5. When there is doubt that the assumptions for t-tests are satisfied, researchers sometimes use non-parametric rank-order procedures such as the Wilcoxon-Mann-Whitney rank-sum test for independent groups or the Wilcoxon signed rank-sum test for paired observations. These procedures are permutation tests for differences between mean-ranks and are invalid tests for differences between medians or means (Arboretti et al., 2018).

Nonparametric tests are described as distribution-free methods, which means that they are not based on distributional assumptions on data (Pesarin, 2020).

Non-parametric statistical tests can be mainly classified into two types of procedures: rank-based tests and permutation tests. Permutation tests, which refer to a type of non-parametric procedure called conditional, have the interesting property of being exact for any, sample size even very small. This means that their null distributions, which are used to calculate the p-values, are known for any given set of data and for any sample size and this implies that the relative inferential errors, the so-called Type I and II errors can be managed exactly by researcher.

In contrast, non-parametric rank-based tests are mostly asymptotic-type procedures, which means that their validity is guaranteed only for large sample sizes, where the broad term is often vague and difficult to evaluate in real problems (Wolski et al., 2020).

The choice of using non-parametric statistical techniques is particularly suitable for the observational context where generally no underlying distribution (for example, the normality of the data) is assumed, and sometimes it is not even possible to hypothesize, and in some cases only samples are available of low numbers (Giacalone et al., 2018b).

The solution in question is provided by the methodology known as the non-parametric combination of dependent permutation tests (Non-Parametric Combination Test, NPC). NPC method is a statistical procedure conditional on a set of sufficient statistics, characterized by good sensitivity (power of the statistical test) or a low propensity to false negatives (type II error) and this is true for any sample size so also for small samples (Bonnini et al., 2014). By using NPC methodology, the researcher is free from specify the most difficult part of the data modeling, that is the dependence structure between variables under consideration. In the context of hypothesis testing, the use of a model that describes the dependence structure

between variables is usually very restrictive for the analysis and not always appropriate. Instead, in the NPC approach the dependence structure between the variables in question is obtained automatically and implicitly, this is very important especially in the presence of non-normal or categorical variables whose dependence relationships are generally very difficult to define and manage in the analysis phase (Corain & Salmaso, 2015).

In conclusion, we notice that, especially when the number of variables is large, the underlying dependence structure can be more complex than pair-wise linear, as it is common described by multivariate Gaussian distribution. So, it is impossible to deal with it by proper estimator of all related regression coefficients, the number and the type of which are typically unknown. Thus, it must be worked out non-parametrically. This implies turning to the permutation testing principle and specifically to the NPC (Winkler et al., 2016).

2.3. NPC: methodological issue

The NPC methodology allows to obtain a correct and consistent estimate of the permutation distributions of the tests and of the relative p-values, both for the partial tests and for the combined tests and allows to achieve effective solutions of multidimensional hypothesis testing problems, in the context of non-parametric permutation inference (Pesarin, 1997). Starting from the identification of two or more groups of statistical units with respect to a classification criterion, it is verified whether statistically significant differences exist between the groups with respect to the set of response variables (Pesarin, 2020).

First, consider the two main properties enjoyed by permutation tests, assuming that the exchangeability of the data between the groups in null hypothesis holds, namely:

• property of similarity, as whatever the distribution underlying the data, the probability of rejection under the null hypothesis is invariant with respect to the set of data actually observed, and this whatever the method of disclosure of the data;

• for any level of significance α, for any underlying distribution and for all possible observed datasets, if under the alternative the distribution dominates the null or is dominated by the null, then there exists an undistorted conditional test, in the sense that the probability of rejection of the null hypothesis is always lower than the significance level α.

These two properties, respectively, guarantee that the conditional probability of rejecting H_0, when it is true, is always equal to the significance level α, regardless of how the data are detected, and that the conditional probability of rejecting H_0, when H_1 is true, it is always not less than the chosen level of significance α, under the condition, however, that the data can be exchanged

between groups. Thanks to these two characteristics, the inferences associated with permutation tests can be extended to the entire target population, respecting the properties of non-distortion and consistency.

Wanting to compare the NPC test to the classic approach we can notice that:

- it does not require normality and homoscedasticity assumptions (Janssen, 1977; Klingenberg et al., 2009);
- it draws any type of variable;
- it holds a good behavior even in presence of missing data.

The missing data can be missing at random (MAR) or not missing at random (NMAR). "The missing data are missing at random (MAR), if the conditional probability of the observed pattern of missing data given the missing data and the value of the observed data is the same for all possible values of the missing data. If the missing data are missing not at random (MNAR), then in order to make valid parametric inferences, the missing data process must be properly specified. The specification of a model which correctly represents the missing data process seems the only way to eliminate the inferential bias caused by non-responses in a parametric framework. In the literature, various models have been proposed, most of which concern cases in which non-responses are confined to a single variable" (Pesarin & Salmaso, 2010).

We can assert that the permutation analysis can be carried out when there is missingness and is valid when we have missing completely at random (MCAR) data. In this sense, NPC test permit to ignore missingness by abolishing all unobserved units from the data set and to obtain exact permutation solutions (Giacalone et al., 2018b);

- it is powerful in presence of low sampling size (Brombin & Salmaso, 2009);
- It resolves multivariate problems without the necessity to specify the dependence structure among variables (Basso et al., 2007; Giancristofaro & Brombin, 2014; Friedrich et al., 2017);
- it allows stratified analyses;
- it permits to test multivariate restricted alternative hypothesis;
- it solves problems in which the number of observed subjects is smaller than that of variables (Finos & Salmaso, 2006).

Then we need to introduce the principle of permutation tests: it states that if two experiments with values in the same sample space produce the same set of observed data X and condition of exchangeability is verified under H_0, then the X's conditioned inferences, obtained by using the same statistic test T, must match regardless of the underlying probability distributions.

The X's conditioning makes the distribution of T "distribution free" and rejection regions similar as stated by Scheffè (1943).

So, by implementing the permutation test methodology, it goes through two phases:

1. decomposition of the multivariate hypothesis system into one-dimensional sub-hypotheses, for each of which there is a partial permutation test. This serves to examine the marginal contribution of each individual response variable in the comparison between the two groups (Arboretti et al., 2020);
2. non-parametric combination of partial tests in a single second-order test relating to the multivariate global hypothesis.

If within the analysis there is also a stratification variable, two levels of combination are foreseen which, respectively, combine first the partial tests in combined second order tests, each corresponding to the i-th stratum, and then combine the combined tests into a single third-order combined test.

Moreover, we underline that considering the set of p-values (p_{si}) for test the respective set of partial null hypotheses (H_{0s}), a union–intersection test considers the joint null hypothesis corresponding to a global null hypothesis that all H_{0s} are true; if any such partial null is rejected, the global null hypothesis is also rejected (Roy, 1953).

Single multivariate tests, such as classical ones like multivariate analysis of variance (MANOVA), multivariate analysis of covariance (MANCOVA), or canonical correlation/variates analysis (CCA/CVA), will be referred here as classical multivariate tests (CMV). The combination of multiple univariate hypotheses requires each one to be analyzed separately, and these results to be grouped together to test, at each stratum, the joint null hypothesis. So, the separate tests are defined *Partial Tests*.

Based on the criterion used for the rejection of the joint null hypothesis, three different categories of combined tests arise:

1. reject if any partial test is significant (Tippet, 1931);
2. reject if all partial tests are significant (Berger, 1982);

3. reject if some aggregate measure from the partial tests is significant and that offers a trade-off between the two other approaches and leads to a large number of possible tests, each with a different rejection region, and thus with different sensitivity and specificity profiles.

Single multivariate test or the combination of multiple univariate tests can be assessed parametrically when the asymptotic distribution of the test statistic is known, if various assumptions about the data are respected. These refer, in principle, to the independence or common dependence between observations and between tests, to the distribution of the error terms. If the observations are exchangeable, that is, if their joint distribution remains unchanged after stirring, then all such assumptions can be avoided at once, and instead, permutation tests can be performed. The p-values can then be computed for either the classical multivariate tests, or for the combination of univariate tests, and in this case, we consider non-parametric combination method (Pesarin, 1990, 2001).

Exchangeability is assumed only for the observations within each partial test and exchangeability is not assumed between the partial tests for either classical multivariate tests or non-parametric combination (Giacalone et al, 2018).

Preliminarily, we define a set of K one-dimensional permutation test, denominated partial test, through which the marginal contribution of every response-variable can be examined while comparing groups.

Using an opportune combination function, the partial tests are non-parametrically merged through Conditional Monte Carlo procedure in combined tests.

Let us suppose that K variables are observed on C groups of nc subjects each, c=1,2. So, the data assumed to be observed on independent individuals are $X=(X_{icu}, i=1,...,k; c=1,2; u=1,...,nc)$.

According to Roy's Union-Intersection notation, the null hypothesis states the distributional equality in of two K-dimensional variables, that is:

$$\boldsymbol{H_0: P_1 = P_2} \equiv \bigcap_{\boldsymbol{i=1}}^{\boldsymbol{k}} (\boldsymbol{X_{i1} \overset{d}{=} X_{i2}}) = \bigcap_{\boldsymbol{i=1}}^{\boldsymbol{k}} \boldsymbol{H_{0i}}$$

where a breakdown into K sub-null hypotheses is emphasized. Indeed, global H_0 is true if all K sub-null are jointly true. The alternative is

$$\boldsymbol{H_1}: \bigcup_{\boldsymbol{i=1}}^{\boldsymbol{k}} (\boldsymbol{X_{i1} \overset{d}{\neq} X_{i2}}) = \bigcup_{\boldsymbol{i=1}}^{\boldsymbol{k}} \boldsymbol{H_{1i}}$$

which is true when at least one sub-alternative is true.

The non-parametric combination of the dependent partial tests in second order s tests, relative to each stratum, and subsequently the combination of the second order tests, for each stratum, in a single combined third order test, relative to the global hypothesis, occurs using a conditional resampling procedure; it is obtained through a resampling without replacement, conditional on the set of observed data, known as Conditional Monte Carlo Procedure (CMCP). This resampling of the set of data X is a random survey from the set P (X) of the possible permutations of the same data, to which H_0 assigns equal probability, so that it is possible to obtain good estimates of the distribution in H_0 of any test statistic. Any resampling without replacement X* from data set X consists of a random attribution of individual data vectors to the C samples; higher the number of conditioned resampling is, better and more reliable the resulting inferences will be. In all X_r*, r=1,...,*B*, the partial tests are calculated to obtain the set of values [T_{ir}*=$T(X_{ir}$*), i=1,…,*k*; r=1,…,*B*], where *B* are the independent random resamplings. This procedure allows obtaining a consistent estimate of both marginal and joint permutation distributions of the partial tests (Pesarin, 1992). The conditional resampling procedure is also used to combine second order tests into a single global third order test for all possible strata (Alfieri et al., 2016; Corain & Salmaso, 2004; Folks, 1984; Pesarin, 1990). The CMCP, under the general null hypothesis, allows a consistent estimation of the permutation distributions, of the k partial tests, both marginal and combined. We consider Fisher's combination function, for its properties which are both finite and asymptotic. If it were considered appropriate, it would be possible to consider any other combining function. The combined test is unbiased, consistent and it has asymptotic properties (Folks, 1984; Pesarin, 2001).

2.4. The Data

The sample consists of nurses operating in the field of assistance to ALS patients, in hospitals located in Southern Italy. The choice of the sample followed a probabilistic criterion (cluster sample). Initially, hospitals with wards dedicated to ALS patients were identified and their random extraction was carried out (completely randomized procedure). Among the extracted hospitals, all nurses were asked to complete the HPSCS questionnaire. Only 3% of them refused to participate in the survey. To protect the privacy of respondents, the questionnaire is anonymous. The sample of nurses who answered the questions in the questionnaire, with prior informed consent, consisted of 105 people, of which 42% was male and 58% was female, with an average age of 37.5±10.4 years. The 48.6% of the sample has a nursing diploma, the remaining percentage (51.4%) has a degree. In addition, nurses working in the Neuromuscular Diseases ward represent 28.6%, while the remainder (71.4%) work in the Intensive Neurorehabilitation ward.

3. Results and discussion

The analyses, carried out by NPC test, were stratified according to different confounding factors, in order to control their potential effect.

Our analysis foresees two sections, the first related to the areas of stress and the second to the coping strategies adopted by each respondent within every stress area. Each table has been divided into two parts: the "a" part shows the descriptive statistics (mean ± standard deviation SD) of the numerical variables, while the "b" part shows the partial and combined p-values obtained by applying the NPC test, referring to different comparisons between groups. The variable "Problematic relationships with patients and family members" was abbreviated as "Problematic relationships" and the variable "Unexpected organizational events" as "Unexpected organiz. events can be drawn.

3.1. NPC test for areas of stress evaluation

In Tables 1-6 the areas of stress were focused; in particular, comparisons were made:

-between gender, educational qualifications and wards, stratifying by risk classes

-between risk classes, stratifying by gender, educational qualifications and wards.

Statistically significant p-values ($p < 0.050$) are highlighted in bold and, in addition, the verse "<" or ">" was specifically indicated.

For all analyses, the NonParametric Combination Test Software *(Version 2.0, Statistical Software for Multivariate NonParametric Permutation Tests*) was used.

Table 1a. Mean ±SD of T-scores for stress areas and gender, stratifying for exposure risk

Stress Areas	**Stratum 1: Low Risk**		
	Male	**Female**	**Pooled sample**
Clinical emergency	57.00 ± 8.76	50.33 ± 10.84	51.12 ± 10.76
Problematic relationships	46.50 ± 11.50	50.20 ± 7.33	49.76 ± 7.87
Personal attack	49.00 ± 10.95	50.60 ± 5.65	50.41 ± 6.35
Personal devaluation	45.50 ± 10.41	50.93 ± 6.03	50.29 ± 6.78
Unexpected organiz. events	45.50 ± 14.79	49.33 ± 11.09	48.88 ± 11.47
	Stratum 2: High Risk		
Clinical emergency	43.40 ± 7.04	50.62 ± 9.62	48.61 ± 9.49
Problematic relationships	42.60 ± 5.58	53.38 ± 11.57	50.39 ± 11.32
Personal attack	49.80 ± 5.34	49.85 ± 14.30	49.83 ± 12.42
Personal devaluation	43.40 ± 7.31	51.77 ± 13.64	49.44 ± 12.72
Unexpected organiz. events	44.60 ± 4.56	54.00 ± 8.22	51.39 ± 8.49

Table 1b. Partial and combined p-values of comparison for gender (M vs F) and stress area stratifying for exposure risk

Stress Areas	Low Risk	High Risk		Combined
Clinical emergency	0.162	**0.007 <**	→	**0.009**
Problematic relationships	0.402	**0.001 <**	→	**0.002**
Personal attack	0.505	0.982	→	0.817
Personal devaluation	**0.026 <**	**0.026 <**	→	**0.004**
Unexpected organiz. events	0.508	**0.001 <**	→	**0.001**
	↓	↓		↓
Combined	0.125	**0.001**	→	**0.000**

From the results, shown in Table 1, we note that, in general, males show lower stress levels than females: in particular for those exposed to a low risk, only the "Personal devaluation" item is significant; in high risk, on the other hand, a significance is highlighted for all items, except for "Personal attacks". The significance found in the partial p-values reflects in the combined p-values.

Table 2a. Mean ±SD of T-scores for stress areas and educational status, stratifying for exposure risk

Stress Areas	Stratum 1: Low Risk		
	Diploma	**Degree**	**Pooled sample**
Clinical emergency	51.67 ± 4.00	51.00 ± 11.75	51.12 ± 10.76
Problematic relationships	53.67 ± 5.00	48.93 ± 8.16	49.76 ± 7.87
Personal attack	78.00 ± 3.00	50.93± 6.77	50.41 ± 6.35
Personal devaluation	51.67 ± 5.00	50.00 ± 7.12	50.29 ± 6.78
Unexpected organiz. events	53.00 ± 9.00	48.00 ± 11.84	48.88 ± 11.47
	Stratum 2: High Risk		
Clinical emergency	47.43 ± 7.20	52.75 ± 14.72	48.61 ± 9.49
Problematic relationships	49.86 ± 9.41	52.25 ± 16.80	50.39 ± 11.32
Personal attack	48.64 ± 12.63	54.00 ± 11.15	49.83 ± 12.42
Personal devaluation	48.64 ± 12.29	52.25 ± 14.35	49.44 ± 12.72
Unexpected organiz. events	51.86 ± 7.69	49.75 ± 11.09	51.39 ± 8.49

Table 2b. Partial and combined p-values of comparison for gender (M vs F) and stress area stratifying for exposure risk

Stress Areas	Low Risk	High Risk		Combined
Clinical emergency	0.879	0.104	→	0.298
Problematic relationships	0.148	0.535	→	0.243
Personal attack	0.257	0.174	→	0.172
Personal devaluation	0.494	0.403	→	0.495
Unexpected organiz. events	0.251	0.393	→	0.321
	↓	↓		↓
Combined	0.291	0.229	→	0.266

The educational status does not determine any significant difference in the behaviors of health professionals, whether they are exposed to low or high risk (Table 2).

Table 3a. Mean ±SD of T-scores for stress areas and ward, stratifying for exposure risk

Stress Areas	Stratum 1: Low Risk		
	Neur. Dis.	Int. Neuror.	Pooled sample
Clinical emergency	44.50 ± 4.70	53.15 ± 11.31	51.12 ± 10.76
Problematic relationships	49.50 ± 4.52	49.85 ± 8.70	49.76 ± 7.87
Personal attack	52.50 ± 8.53	49.77 ± 5.49	50.41 ± 6.35
Personal devaluation	50.00 ± 5.22	50.38 ± 7.25	50.29 ± 6.78
Unexpected organiz. events	41.00 ± 6.65	51.31 ± 11.61	48.88 ± 11.47
	Stratum 2: High Risk		
Clinical emergency	44.50 ± 4.63	50.67 ± 10.62	48.61 ± 9.49
Problematic relationships	46.83 ± 10.98	52.17 ± 11.21	50.39 ± 11.32
Personal attack	48.00 ± 16.54	50.75 ± 9.90	49.83 ± 12.42
Personal devaluation	50.17 ± 18.26	49.08 ± 9.09	49.44 ± 12.72
Unexpected organiz. events	52.83 ± 8.431	50.67 ± 8.54	51.39 ± 8.49

Table 3b. Partial and combined p-values of comparison for gender (M vs F) and stress area stratifying for exposure risk

Stress Areas	Low Risk	High Risk		Combined
Clinical emergency	**0.014 <**	**0.026 <**	→	**0.002**
Problematic relationships	0.831	0.081	→	0.218
Personal attack	0.163	0.455	→	0.258
Personal devaluation	0.955	0.920	→	0.994
Unexpected organiz. events	**0.004 <**	0.353	→	**0.011**
	↓	↓		↓
Combined	**0.030**	0.129	→	**0.016**

Working in the "intensive neurorehabilitation" ward significantly increases the stress levels of nurses, compared to those operating in the "neuromuscular diseases" ward only for the "Clinical emergency" item (whatever the exposure to risk) and for the "Unexpected organizational events" item only for those exposed to low risk (Table 3).

Table 4a. Mean ±SD of T-scores for stress areas and exposure risk, stratifying for gender

Stress Areas	**Stratum 1: Male**		
	Low risk	**High risk**	**Pooled sample**
Clinical emergency	57.00 ± 8.76	43.40 ± 7.04	47.29 ± 9.67
Problematic relationships	46.50 ± 11.50	42.60 ± 5.58	43.71 ± 7.62
Personal attack	49.00 ± 10.95	49.80 ± 5.34	49.57 ± 7.08
Personal devaluation	45.50 ± 10.41	43.40 ± 7.31	44.00 ± 8.09
Unexpected organiz. events	45.50 ± 14.79	44.60 ± 4.56	44.86 ± 8.33
	Stratum 2: Female		
Clinical emergency	50.33 ± 10.84	50.62 ± 9.62	50.46 ± 10.23
Problematic relationships	50.20 ± 7.33	53.38 ± 11.57	51.68 ± 9.61
Personal attack	50.60 ± 5.65	49.85 ± 14.30	50.25 ± 10.52
Personal devaluation	50.93 ± 6.03	51.77 ± 13.94	51.32 ± 10.23
Unexpected organiz. events	49.33 ± 11.09	54.00 ± 8.22	51.50 ± 10.08

Table 4b. Partial and combined p-values of comparison for exposure (low vs high) for each stress area, stratifying for gender

Stress Areas	**Male**	**Female**		**Combined**
Clinical emergency	0.893	**0.001 <**	→	**0.006**
Problematic relationships	0.123	0.318	→	0.142
Personal attack	0.762	0.882	→	0.923
Personal devaluation	0.750	0.618	→	0.782
Unexpected organiz. events	0.056	0.959	→	0.128
	↓	↓		↓
Combined	0.258	0.117	→	0.093

Within the group of women, those exposed to low risk show significantly lower levels of stress than those subjected to high risk, with reference only to the "Clinical emergency" item, significance also confirmed by the combined p-value (Table 4).

Table 5a. Mean ±SD of T-scores for stress areas and exposure risk, stratifying for educational status

Stress Areas	Stratum 1: Diploma		
	Low risk	**High risk**	**Pooled sample**
Clinical emergency	51.67 ± 4.00	47.43 ± 7.20	48.18 ± 6.90
Problematic relationships	53.67 ± 5.00	49.86 ± 9.41	50.53 ± 8.87
Personal attack	48.00 ± 3.00	48.64 ± 12.63	48.53 ± 11.50
Personal devaluation	51.67 ± 5.00	48.64 ± 12.29	49.18 ± 11.36
Unexpected organiz. events	53.00 ± 9.00	51.86 ± 7.69	52.06 ± 7.85
	Stratum 2: Degree		
Clinical emergency	51.00 ± 11.75	52.75 ± 14.72	51.39 ± 12.34
Problematic relationships	48.93 ± 8.16	52.25 ± 16.80	49.67 ± 10.59
Personal attack	50.93 ± 6.77	54.00 ± 11.15	51.61 ± 7.94
Personal devaluation	50.00 ± 7.12	52.25 ± 14.35	50.50 ± 9.10
Unexpected organiz. events	48.00 ± 11.84	49.75 ± 11.09	48.39 ± 11.60

Table 5b. Partial and combined p-values of comparison for exposure (low vs high) for each stress area, stratifying for educational status

Stress Areas	Diploma	Degree		Combined
Clinical emergency	0.070	0.719	→	0.185
Problematic relationships	0.275	0.329	→	0.281
Personal attack	0.895	0.254	→	0.544
Personal devaluation	0.498	0.493	→	0.564
Unexpected organiz. events	0.749	0.713	→	0.854
	↓	↓		↓
Combined	0.368	0.506	→	0.495

Within educational status groups, we find no significant differences in the comparison between those exposed to low or high risk (Table 5).

Table 6a. Mean ±SD of T-scores for stress areas and exposure risk, stratifying for ward

Stress Areas	Stratum 1: Neuromuscular Diseases		
	Low risk	**High risk**	**Pooled sample**
Clinical emergency	44.50 ± 4.70	44.50 ± 4.63	44.50 ± 4.60
Problematic relationships	49.50 ± 4.52	46.83 ± 10.98	47.90 ± 8.95
Personal attack	52.50 ± 8.53	48.00 ± 16.54	49.80 ± 13.89
Personal devaluation	50.00 ± 5.22	50.17 ± 18.26	50.10 ± 14.34
Unexpected organiz. events	41.00 ± 6.65	52.83 ± 8.43	48.10 ± 9.65

	Stratum 2: Intensive Neurorehabilitation		
Clinical emergency	53.15 ± 11.31	50.67 ± 10.62	51.96 ± 10.98
Problematic relationships	49.85 ± 8.70	52.17 ± 11.21	50.96 ± 9.98
Personal attack	49.77 ± 5.49	50.75 ± 9.90	50.24 ± 7.88
Personal devaluation	50.38 ± 7.25	49.08 ± 9.09	49.76 ± 8.15
Unexpected organiz. events	51.31 ± 11.61	50.67 ± 8.53	51.00 ± 10.19

Table 6b. Partial and combined p-values of comparison for exposure (low vs high) for each stress area, stratifying for ward

Stress Areas	Neur. Dis.	Int. Neuror.		Combined
Clinical emergency	0.959	0.332	→	0.566
Problematic relationships	0.487	0.335	→	0.432
Personal attack	0.408	0.584	→	0.573
Personal devaluation	0.929	0.506	→	0.806
Unexpected organiz. events	**0.001 <**	0.805	→	**0.003**
	↓	↓		↓
Combined	0.061	0.581	→	0.150

Among nurses operating in the neuromuscular diseases ward, those exposed to low risk have significantly lower stress levels than highly exposed, only for the "Unexpected organizational events" item (Table 6).

3.2. NPC test for coping strategies within each stress area

In Tables 7-12 we focused on the coping strategies adopted by each respondent within every stress area. Each table has been divided into two parts: the "a" part shows the descriptive statistics (mean ± standard deviation SD) of the numerical variables, while the "b" part shows the partial and combined p-values obtained by applying the NPC test, referring to different comparisons between groups.

The variable "Problematic relationships with patients and family members" was abbreviated as "Problematic relationships"; the variable "Unexpected organizational events" as "Unexpected organiz. events" and the wards as "Neur. Dis." and "Int. Neuror."

Table 7a. Mean ±SD of T-scores for coping areas and gender, stratifying for exposure risk

Stress Areas	Coping Strategies	Stratum 1: Low Risk		
		Male	**Female**	**Pooled sample**
Clinical emergency	Social Support	45.50 ± 6.03	52.20 ± 10.74	51.41 ± 10.48
	Avoidance of the problem	68.00 ± 14.24	48.20 ± 8.19	50.53 ± 10.99
	Solution of the problem	55.00 ± 0.02	49.40 ± 11.00	50.06 ± 10.48
	Emotional Disadvantage	47.50 ± 9.31	49.47 ± 7.94	49.24 ± 8.03
Problematic relationships	Social Support	40.00 ± 7.67	51.53 ± 9.54	50.18 ± 10.01
	Avoidance of the problem	62.50 ± 21.36	49.20 ± 7.52	50.76 ± 10.68
	Solution of the problem	66.50 ± 2.74	47.40 ± 10.40	49.65 ± 11.60
	Emotional Disadvantage	50.00 ± 13.15	50.13 ± 9.80	50.12 ± 10.09
Personal attack	Social Support	42.00 ± 0.04	53.07 ± 9.95	51.76 ± 10.01
	Avoidance of the problem	58.00 ± 0.05	47.33 ± 5.44	48.59 ± 6.17
	Solution of the problem	38.00 ± 5.48	48.00 ± 10.11	46.82 ± 10.18
	Emotional Disadvantage	53.50 ± 15.88	49.73 ± 6.81	50.18 ± 8.22
Personal devaluation	Social Support	34.00 ± 12.05	53.53 ± 9.58	51.24 ± 11.65
	Avoidance of the problem	52.00 ± 0.07	49.07 ± 10.71	49.41 ± 10.09
	Solution of the problem	32.50 ± 16.98	48.53 ± 9.56	46.64 ± 11.68
	Emotional Disadvantage	42.50 ± 3.83	50.60 ± 9.69	49.65 ± 9.54
Unexpected organizational events	Social Support	32.50 ± 8.22	52.73± 8.06	50.35 ± 10.36
	Avoidance of the problem	53.50 ± 3.83	49.20 ± 11.34	49.71 ± 10.80
	Solution of the problem	48.00 ± 4.38	51.13 ±11.23	50.76 ± 10.67
	Emotional Disadvantage	51.50 ± 13.69	51.20 ± 8.28	51.24 ± 8.89
Stress Areas	**Coping Strategies**	**Stratum 2: High Risk**		
Clinical emergency	Social Support	51.60 ± 9.23	47.85 ± 9.58	48.89 ± 9.55
	Avoidance of the problem	56.60 ± 9.92	46.23 ± 7.56	49.11 ± 9.43
	Solution of the problem	47.60 ± 7.82	50.92 ± 10.23	50.00 ± 9.66
	Emotional Disadvantage	51.80 ± 9.45	50.38 ± 12.52	50.78 ± 11.68
Problematic relationships	Social Support	59.00 ± 3.46	46.46 ± 9.74	49.94 ± 10.16
	Avoidance of the problem	49.80 ± 7.56	49.08 ± 10.21	49.28 ± 9.49
	Solution of the problem	45.00 ± 6.04	52.46 ± 8.75	50.39 ± 8.71
	Emotional Disadvantage	56.20 ± 8.57	47.62 ± 9.87	50.00 ± 10.21
Personal attack	Social Support	48.60 ± 4.84	48.23 ± 11.59	48.33 ± 10.13
	Avoidance of the problem	51.20 ± 11.46	51.31 ± 13.10	51.28 ± 12.56
	Solution of the problem	49.00 ± 5.07	53.77 ± 10.10	52.44 ± 9.20
	Emotional Disadvantage	48.60 ± 4.17	50.08 ± 13.44	49.67 ± 11.60
Personal devaluation	Social Support	46.40 ± 5.42	49.31 ± 8.59	48.50 ± 7.90
	Avoidance of the problem	53.40 ± 13.07	49.77 ± 8.45	50.78 ± 9.95
	Solution of the problem	49.60 ± 6.20	54.15 ± 7.22	52.89 ± 7.19
	Emotional Disadvantage	55.00 ± 8.28	48.85 ± 10.56	50.56 ± 10.28
Unexpected organizational events	Social Support	50.20 ± 10.62	49.69 ± 9.97	49.83 ±10.06
	Avoidance of the problem	54.40 ± 6.16	49.46 ± 9.43	50.11 ± 9.00
	Solution of the problem	45.40 ± 7.74	51.08 ± 9.37	49.50 ± 9.24
	Emotional Disadvantage	46.80 ± 6.78	49.15 ± 12.43	48.78 ± 11.10

Table 7b. Partial and combined p-values of comparison for gender (M vs F) for each coping area, stratifying for exposure risk

Stress Areas	Coping Strategies	Low Risk	High		Combined
Clinical emergency	Social Support	0.133	0.204	→	0.119
	Avoidance of the problem	**0.001>**	**0.001>**	→	**0.001**
	Solution of the problem	0.224	0.262	→	0.211
	Emotional Disadvantage	0.583	0.705	→	0.766
Problematic relationships	Social Support	**0.006<**	**0.002>**	→	**0.001**
	Avoidance of the problem	**0.008>**	0.790	→	**0.035**
	Solution of the problem	**0.001>**	**0.004<**	→	**0.001**
	Emotional Disadvantage	0.996	**0.005>**	→	**0.027**
Personal attack	Social Support	**0.007<**	0.936	→	**0.038**
	Avoidance of the problem	**0.001>**	0.981	→	**0.001**
	Solution of the problem	**0.020<**	0.101	→	**0.013**
	Emotional Disadvantage	0.308	0.703	→	**0.526**
Personal devaluation	Social Support	**0.001<**	0.283	→	**0.001**
	Avoidance of the problem	0.512	0.259	→	0.381
	Solution of the problem	**0.002<**	**0.041<**	→	**0.006**
	Emotional Disadvantage	**0.006<**	**0.043>**	→	**0.018**
Unexpected organizational events	Social Support	**0.001<**	0.915	→	**0.001**
	Avoidance of the problem	0.406	**0.028>**	→	0.067
	Solution of the problem	0.534	**0.044<**	→	0.102
	Emotional Disadvantage	0.975	0.724	→	0.945
		↓	↓		↓
Combined		**0.001**	**0.008**		**0.001**

Examining results (Table 7) we note that within the "Clinical emergency" stress area, the only significances, both in low-risk and high-risk exposures, are found in correspondence with the "Avoidance of the problem" item, in which males show a greater tendency to avoid problems. In correspondence with the "problematic relationship" area, among those exposed at low risk, females require more support to solve problematic situations, while males are characterized by wanting to avoid the problem or face it by seeking the most appropriate solution. Among those exposed to high risk, males require more social support and show greater emotional distress. On the other hand, however, they are less likely than women to face problems in order to find a solution. As regards the "Personal attack" item, we found only significances among those exposed at low risk, with females more likely to request social support and to face the problem and with males, instead, more inclined to avoid problems. A similar situation is found among the subjects exposed to low risk for the "Personal devolution" item: also for this area, women show a greater propensity, than men, to request social support and face problems to reach a solution; but they also manifest significantly greater emotional distress than men. In the same stress area, among those exposed to high risk, only two significances are noted; the first corresponds to the "Solution of the problem" coping area in which the verse < highlights a

greater use of this strategy by women; the second refers to "Emotional disadvantage" item characterized by greater emotional distress in men.

Table 8a. Mean ±SD of T-scores for coping areas and educational status, stratifying for exposure risk

Stress Areas	**Coping Strategies**	**Stratum 1: Low Risk**		
		Diploma	**Degree**	**Pooled sample**
Clinical emergency	Social Support	42.00 ± 6.00	53.43 ± 10.16	51.41 ± 10.48
	Avoidance of the problem	46.67 ± 3.50	51.36 ± 11.88	50.53 ± 10.99
	Solution of the problem	44.33 ± 4.77	51.29 ± 10.99	50.06 ± 10.48
	Emotional Disadvantage	50.67 ± 5.29	48.93 ± 8.52	49.24 ± 8.03
Problematic relationships	Social Support	50.33 ± 3.04	50.14 ± 10.97	50.18 ± 10.01
	Avoidance of the problem	49.67 ± 5.64	51.00 ± 11.51	50.76 ± 10.68
	Solution of the problem	40.67 ± 2.50	51.57 ± 11.89	49.65 ± 11.60
	Emotional Disadvantage	62.00 ± 0.04	47.57 ± 9.31	50.12 ± 10.09
Personal attack	Social Support	48.33 ± 6.14	52.50 ± 10.57	51.76 ± 10.01
	Avoidance of the problem	46.67 ± 5.77	49.00 ± 6.24	48.59 ± 6.17
	Solution of the problem	34.67 ± 2.50	49.43 ± 9.26	46.82 ± 10.18
	Emotional Disadvantage	54.67 ±2.54	49.21 ± 8.71	50.18 ± 8.22
Personal devaluation	Social Support	49.67 ± 9.26	51.57 ± 12.17	51.24 ± 11.65
	Avoidance of the problem	52.00 ± 0.08	48.86 ± 11.06	49.41 ± 10.09
	Solution of the problem	40.00 ± 6.93	48.07 ± 12.05	46.65 ± 11.68
	Emotional Disadvantage	61.33 ±3.50	47.14 ± 8.50	49.65 ± 9.54
Unexpected organizational events	Social Support	52.33 ±4.00	49.93 ± 11.25	50.35 ± 10.36
	Avoidance of the problem	54.67 ± 10.11	48.64 ± 10.76	49.71 ± 10.80
	Solution of the problem	49.33 ± 4.00	51.07 ± 11.63	50.76 ± 10.67
	Emotional Disadvantage	58.00 ± 0.09	49.79 ± 9.18	51.24 ± 8.89
Stress Areas	**Coping Strategies**	**Stratum 2: High Risk**		
Clinical emergency	Social Support	47.36 ± 9.75	54.25 ±6.66	48.89 ± 9.55
	Avoidance of the problem	48.79 ± 10.39	50.25 ± 5.59	49.11 ± 9.43
	Solution of the problem	51.21 ± 9.84	45.75 ± 7.29	50.00 ± 9.66
	Emotional Disadvantage	47.50 ± 9.50	62.25 ± 11.69	50.78 ± 11.68
Problematic relationships	Social Support	49.86 ± 10.13	50.25 ± 10.71	49.94 ± 10.16
	Avoidance of the problem	48.71 ± 9.04	51.25 ± 11.11	49.28 ± 9.49
	Solution of the problem	50.43 ± 9.45	50.25 ± 5.69	50.39 ± 8.71
	Emotional Disadvantage	49.00 ± 9.91	53.50 ± 10.92	50.00 ± 10.21
Personal attack	Social Support	47.43 ± 10.61	51.50 ± 7.76	48.33 ± 10.13
	Avoidance of the problem	49.93 ± 9.35	56.00 ± 20.08	51.28 ± 12.56
	Solution of the problem	52.29 ± 9.34	53.00 ± 9.05	52.44 ± 9.20
	Emotional Disadvantage	47.64 ± 8.22	56.75 ± 18.05	49.67 ± 11.60
Personal devaluation	Social Support	48.00 ± 7.44	50.25 ± 9.50	48.50 ± 7.90
	Avoidance of the problem	50.43 ± 9.35	52.00 ± 12.23	50.78 ± 9.95
	Solution of the problem	52.57 ± 7.32	54.00 ± 6.93	52.89 ± 7.19
	Emotional Disadvantage	48.57 ± 8.70	57.50 ± 12.65	50.56 ± 10.28
Unexpected organizational events	Social Support	50.00 ± 10.08	49.25 ± 10.40	49.83 ± 10.06
	Avoidance of the problem	50.21 ± 9.82	49.75 ± 5.55	50.11 ± 9.00
	Solution of the problem	50.57 ± 9.21	45.75 ± 8.69	49.50 ± 9.24
	Emotional Disadvantage	46.21 ± 7.65	57.75 ± 16.20	48.78 ± 11.10

Table 8b. Partial and combined p-values of comparison for educational status (diploma vs degree) for each coping area, stratifying for exposure risk

Stress Areas	Coping Strategies	Low	High Risk		Combined
Clinical emergency	Social Support	**0.002<**	**0.025<**	→	**0.003**
	Avoidance of the problem	0.258	0.651	→	0.443
	Solution of the problem	0.074	0.086	→	0.036
	Emotional Disadvantage	0.576	**0.001<**	→	**0.001**
Problematic relationships	Social Support	0.958	0.912	→	0.990
	Avoidance of the problem	0.762	0.425	→	0.670
	Solution of the problem	**0.008<**	0.955	→	**0.043**
	Emotional Disadvantage	**0.001>**	0.194	→	**0.001**
Personal attack	Social Support	0.263	0.222	→	0.209
	Avoidance of the problem	0.319	0.139	→	0.171
	Solution of the problem	**0.001<**	0.863	→	**0.001**
	Emotional Disadvantage	0.074	**0.014<**	→	**0.008**
Personal devaluation	Social Support	0.684	0.475	→	0.630
	Avoidance of the problem	0.407	0.647	→	0.597
	Solution of the problem	0.061	0.547	→	0.126
	Emotional Disadvantage	**0.001>**	**0.007<**	→	**0.001**
Unexpected organizational events	Social Support	0.557	0.884	→	0.819
	Avoidance of the problem	0.149	0.888	→	0.375
	Solution of the problem	0.696	0.104	→	0.246
	Emotional Disadvantage	**0.009>**	**0.001<**	→	**0.001**
		↓	↓		↓
Combined		**0.001**	**0.025**		**0.001**

Within the two risk areas (Table 8), the comparison between educational qualifications highlighted some particularities. In "Clinical emergency" area, nurses with a diploma, both exposed to low and high risk, are less inclined than graduates to avail themselves of social support. In addition, we can note another significance that refers to nurses with a diploma, exposed to high-risk, who show less ability to manage emotions than their colleagues with a degree. In "Problematic relationship" area we can find two significances, both in the low-risk group. The first denotes that graduates have greater difficulty in finding suitable solutions to deal with problematic situations; the second shows that graduates, more than nurses with degrees, have very strong emotional reactions, difficult to manage, in the face of various problems. In "Personal attack" area, we observe two significances: the first concerns those exposed to low risk, in which graduates show a lower predisposition, compared to colleagues with a degree, to face and solve problematic situations; the second significance is found in those exposed to high risk, where we note that graduates, more than subjects with a degree, are able to manage and control their emotional level in face of problems that occur during their work. In relation to "Personal devaluation" area, both of the significances we have found are attributable to the "emotional disadvantage". Graduates belonging to the "Low risk" group have greater difficulty in adequately managing their work emotions, while a diametrically opposite

situation occurs in the group of high-risk exposure. Focusing on the "Unexpected organizational events" area, the "Emotional disadvantage" item shows two significances, in which the behavior of subjects with a diploma and a degree is opposite. In the low-risk area of exposure, graduates significantly show their less ability to manage emotionally strong situations; the behavior is totally opposite among those exposed to high risk, in which this prerogative is found in nurses with a degree.

Table 9a. Mean ± SD of T-scores for coping areas and wards, stratifying for exposure risk

Stress Areas	**Coping Strategies**	**Stratum 1: Low Risk**		
		Neur. Dis.	**Int. Neuror.**	**Pooled sample**
Clinical emergency	Social Support	54.25 ± 9.15	50.54 ± 10.81	51.41 ±10.48
	Avoidance of the problem	45.25 ± 8.88	52.15 ± 11.73	50.53 ± 10.99
	Solution of the problem	45.50 ± 13.01	51.46 ± 9.32	50.06 ± 10.48
	Emotional Disadvantage	47.75 ± 6.94	49.69 ± 8.37	49.24 ± 8.03
Problematic relationships	Social Support	50.00 ± 10.93	50.23 ± 9.86	50.18 ± 10.01
	Avoidance of the problem	48.00 ± 5.67	51.62 ± 11.73	50.76 ± 10.68
	Solution of the problem	47.75 ± 6.78	50.23 ± 12.74	49.65 ± 11.60
	Emotional Disadvantage	45.25 ± 10.32	51.62 ± 9.66	50.012 ± 10.09
Personal attack	Social Support	54.00 ± 12.66	51.08 ± 9.13	51.76 ± 10.01
	Avoidance of the problem	47.25 ± 6.70	49.00 ± 6.03	48.59 ± 6.17
	Solution of the problem	50.50 ± 4.52	45.69 ± 11.17	46.72 ± 10.18
	Emotional Disadvantage	47.25 ± 6.28	51.08 ± 8.60	50.18 ± 8.22
Personal devaluation	Social Support	53.75 ± 9.50	50.46 ± 12.24	51.24 ± 11.65
	Avoidance of the problem	41.00 ± 4.18	52.00 ± 9.98	49.91 ± 10.09
	Solution of the problem	50.00 ± 12.36	45.62 ± 11.43	46.65 ± 11.68
	Emotional Disadvantage	45.75 ± 8.53	50.85 ± 9.62	49.65 ± 9.54
Unexpected organizational events	Social Support	49.25 ± 10.40	50.69 ± 10.46	50.35 ± 10.36
	Avoidance of the problem	42.00 ± 15.67	52.08 ± 7.61	49.71 ± 10.80
	Solution of the problem	47.75 ± 12.10	51.69 ± 10.19	50.76 ± 10.67
	Emotional Disadvantage	50.00 ± 5.67	51.62 ± 9.70	51.24 ± 8.89
Stress Areas	**Coping Strategies**	**Stratum 2: High Risk**		
Clinical emergency	Social Support	54.50 ± 9.45	46.08 ± 8.39	48.89 ± 9.55
	Avoidance of the problem	52.00 ± 11.55	47.67 ± 7.97	49.11 ± 9.43
	Solution of the problem	50.67 ± 10.01	49.67 ± 9.62	50.00 ± 9.66
	Emotional Disadvantage	56.83 ± 11.86	47.75 ± 10.49	50.78 ± 11.68
Problematic relationships	Social Support	53.67 ± 10.01	48.08 ± 9.85	49.94 ±10.16
	Avoidance of the problem	51.83 ± 10.77	48.00 ± 8.66	49.28 ± 9.49
	Solution of the problem	50.67 ± 10.15	50.25 ± 8.05	50.39 ± 8.71
	Emotional Disadvantage	50.67 ± 5.96	49.67 ± 11.84	50.00 ± 10.21
Personal attack	Social Support	54.50 ± 4.55	45.25 ± 10.77	48.33 ± 10.13
	Avoidance of the problem	58.00 ± 17.46	47.92 ± 7.48	51.28 ± 12.56
	Solution of the problem	53.00 ± 11.88	52.17 ± 7.70	52.44 ± 9.20
	Emotional Disadvantage	54.00 ± 15.58	47.50 ± 8.44	49.67 ± 11.60
Personal devaluation	Social Support	53.17 ± 7.69	46.17 ± 7.00	48.50 ± 7.90
	Avoidance of the problem	56.83 ± 12.20	47.75 ±7.03	50.78 ± 9.95
	Solution of the problem	54.67 ± 5.66	52.00 ± 7.77	52.89 ± 7.19
	Emotional Disadvantage	53.50 ± 12.34	49.08 ± 8.91	50.56 ± 10.28

Unexpected organizational events	Social Support	56.17 ± 2.68	46.67 ± 10.89	49.83 ± 10.06
	Avoidance of the problem	53.33 ± 9.95	48.50 ± 8.16	50.11 ± 9.00
	Solution of the problem	49.17 ± 8.74	49.67 ± 9.60	49.50 ± 9.24
	Emotional Disadvantage	53.83 ± 15.23	46.25 ± 7.36	48.78 ± 11.10

Table 9b. Partial and combined p-values of comparison for ward (neuromuscular diseases vs intensive neurorehabilitation) for each coping area, stratifying for exposure risk

Stress Areas	Coping Strategies	Low Risk	High Risk		Combined
Clinical emergency	Social Support	0.303	**0.001>**	→	**0.003**
	Avoidance of the problem	**0.045<**	0.126	→	**0.035**
	Solution of the problem	0.082	0.710	→	0.219
	Emotional Disadvantage	0.485	**0.005**	→	**0.016**
Problematic relationships	Social Support	0.951	0.057	→	0.204
	Avoidance of the problem	0.321	0.179	→	0.205
	Solution of the problem	0.506	0.932	→	0.793
	Emotional Disadvantage	0.061	0.742	→	0.176
Personal attack	Social Support	0.377	**0.001>**	→	**0.003**
	Avoidance of the problem	0.421	**0.003>**	→	**0.010**
	Solution of the problem	0.170	0.815	→	0.377
	Emotional Disadvantage	0.168	0.062	→	0.058
Personal devaluation	Social Support	0.430	**0.002>**	→	**0.006**
	Avoidance of the problem	**0.001<**	**0.001>**	→	**0.001**
	Solution of the problem	0.275	0.263	→	0.209
	Emotional Disadvantage	0.108	0.154	→	0.078
Unexpected organizational events	Social Support	0.725	**0.001**>	→	**0.002**
	Avoidance of the problem	**0.003**<	0.072	→	**0.002**
	Solution of the problem	0.258	0.905	→	0.545
	Emotional Disadvantage	0.613	**0.014>**	→	**0.044**
		↓	↓		↓
Combined		**0.040**	**0.001**		**0.001**

In relation to the coping areas, a comparison was also carried out between nurses belonging to the two hospital wards covered by this work (Table 9). Taking into consideration the exposure to risk, among the subjects exposed to low risk all the significances detected refer to the item "Avoidance of the problem" for the following areas of stress: "Clinical emergency", "Personal devaluation" and "Unexpected organizational events". In each of these areas, the nurses working in the "Neuromuscular diseases" ward show a lower tendency, compared to their colleagues in the "Intensive Neurorehabilitation" ward, to avoid problematic situations that affect the cognitive and behavioral sphere. Among the subjects exposed to high risk, a common significance is found among all areas of stress, except for "Problematic relationship" for which no significance is recorded. In particular, this significance is characterized by a greater need for support and help, expressed by the nurses who work in the "Neuromuscular diseases" ward, compared to colleagues who belong to the other ward. The same behavior is highlighted by the nurses of the "Neuromuscular diseases" ward for the "Avoidance of the problem" item in "Personal Attack" and "Personal devaluation" stress areas. The latter also show a strong inability

to emotionally manage problems and states of agitation in the "Unexpected organizational events" stress area, compared to colleagues of the other ward.

Table 10a. Mean ± SD of T-scores for coping areas and exposure risk, stratifying for gender

Stress Areas	**Coping Strategies**	**Stratum 1: Male**		
		Low Risk	**High Risk**	**Pooled**
Clinical emergency	Social Support	45.50 ± 6.03	51.60 ± 9.23	49.86 ± 8.75
	Avoidance of the problem	68.00 ± 14.24	56.60 ± 9.92	59.86 ± 12.14
	Solution of the problem	55.00 ± 0.02	47.60 ± 7.82	49.71 ± 7.38
	Emotional Disadvantage	47.50 ± 9.31	51.80 ± 9.45	50.57 ± 9.39
Problematic relationships	Social Support	40.00 ± 7.67	59.00 ± 3.46	53.57 ± 10.02
	Avoidance of the problem	62.50 ± 21.36	49.80 ± 7.56	53.43 ± 13.74
	Solution of the problem	66.50 ± 2.74	45.00 ± 6.36	51.14 ± 11.24
	Emotional Disadvantage	50.00 ± 13.15	56.20 ± 8.57	54.43 ± 10.14
Personal attack	Social Support	42.00 ± 0.04	48.60 ± 4.84	46.71 ± 5.07
	Avoidance of the problem	58.00 ± 0.05	51.20 ± 11.46	53.14 ± 10.09
	Solution of the problem	38.00 ± 5.48	49.00 ± 5.07	45.86 ± 7.17
	Emotional Disadvantage	53.50 ± 15.88	48.60 ± 4.17	50.00 ± 8.97
Personal devaluation	Social Support	34.00 ± 12.05	46.40 ± 5.42	42.86 ± 9.48
	Avoidance of the problem	52.00 ± 0.05	53.40 ± 13.07	53.00 ± 10.95
	Solution of the problem	32.50 ± 16.98	49.60 ± 16.20	44.71 ± 12.71
	Emotional Disadvantage	42.50 ± 3.83	55.00 ± 8.28	51.43 ± 9.23
Unexpected organizational events	Social Support	32.50 ± 8.22	50.20 ± 10.62	45.14 ± 12.77
	Avoidance of the problem	53.50 ± 3.83	54.40 ± 6.16	54.14 ± 5.52
	Solution of the problem	48.00 ± 4.38	45.40 ± 7.74	46.14 ± 6.94
	Emotional Disadvantage	51.50 ± 13.69	47.80 ± 6.78	48.86 ± 9.06
Stress Areas	**Coping Strategies**	**Stratum 2: Female**		
Clinical emergency	Social Support	52.20 ± 10.74	47.85 ± 9.58	50.18 ± 10.39
	Avoidance of the problem	48.20 ± 8.19	46.23 ± 7.56	47.29 ± 7.92
	Solution of the problem	49.40 ± 11.00	50.92 ± 10.23	50.11 ± 10.61
	Emotional Disadvantage	49.47 ± 7.94	50.38 ± 12.52	49.89 ± 10.27
Problematic relationships	Social Support	51.53 ± 9.54	46.46 ± 9.74	49.18 ± 9.91
	Avoidance of the problem	49.20 ± 7.52	49.08 ± 10.21	49.14 ± 8.81
	Solution of the problem	47.40 ± 10.40	52.46 ± 8.75	49.75 ± 9.94
	Emotional Disadvantage	50.13 ± 9.80	47.62 ± 9.87	48.96 ± 9.86
Personal attack	Social Support	53.07 ± 9.95	48.23 ± 11.59	50.82 ± 10.95
	Avoidance of the problem	47.33 ± 5.44	51.31 ± 13.10	49.18 ± 9.91
	Solution of the problem	48.00 ± 10.11	53.77 ± 10.10	50.68 ± 10.45
	Emotional Disadvantage	49.73 ± 6.81	50.08 ± 13.44	49.89 ± 10.36
Personal devaluation	Social Support	53.53 ± 9.58	49.31 ± 8.59	51.57 ± 9.32
	Avoidance of the problem	49.07 ± 10.71	49.77 ± 8.45	49.39 ± 9.67
	Solution of the problem	48.53 ± 9.56	54.15 ± 7.22	51.14 ± 8.96
	Emotional Disadvantage	50.60 ± 9.69	48.85 ± 10.56	49.79 ± 10.08
Unexpected organizational events	Social Support	52.73 ± 8.06	49.69 ± 9.97	51.32 ± 9.07
	Avoidance of the problem	49.20 ± 11.34	48.46 ± 9.43	48.86 ± 10.44
	Solution of the problem	51.13 ± 11.23	51.08 ± 9.37	51.11 ± 10.35
	Emotional Disadvantage	51.20 ± 8.28	49.15 ± 12.43	50.25 ± 10.39

Table 10b. Partial and combined p-values of comparison for exposure (low vs high) for each coping area, stratifying for gender

Stress Areas	Coping Strategies	Male	Female		Combined
Clinical emergency	Social Support	0.164	0.060	→	0.063
	Avoidance of the problem	0.068	0.257	→	0.077
	Solution of the problem	0.076	0.524	→	0.104
	Emotional Disadvantage	0.375	0.678	→	0.584
Problematic relationships	Social Support	**0.001<**	**0.019>**	→	**0.001**
	Avoidance of the problem	0.058	0.949	→	0.175
	Solution of the problem	**0.001>**	**0.022<**	→	**0.001**
	Emotional Disadvantage	0.215	0.247	→	0.201
Personal attack	Social Support	**0.003<**	**0.041>**	→	**0.001**
	Avoidance of the problem	0.185	0.067	→	0.092
	Solution of the problem	**0.001<**	**0.012<**	→	**0.001**
	Emotional Disadvantage	0.294	0.879	→	0.596
Personal devaluation	Social Support	**0.006<**	**0.038>**	→	**0.002**
	Avoidance of the problem	0.874	0.743	→	0.915
	Solution of the problem	**0.005<**	**0.003<**	→	**0.001**
	Emotional Disadvantage	**0.003**<	0.429	→	**0.008**
Unexpected organizational events	Social Support	**0.002<**	0.125	→	**0.002**
	Avoidance of the problem	0.812	0.756	→	0.880
	Solution of the problem	0.445	0.988	→	0.765
	Emotional Disadvantage	0.431	0.367	→	0.431
		↓	↓		↓
Combined		**0.001**	**0.041**		**0.001**

Table 10 shows the p-values deriving from the comparisons, within the group of males and females, separately, between nurses who are exposed at low risk and those who are exposed at high risk. Males exposed at low risk, compared to colleagues subjected to high risk, resort less to support and help from other people (Social Support) in the following stress areas: "Problematic relationship", "Personal attack", "Personal devaluation" and "Unexpected organizational events".

Different situations we can find for the significance of the "Solution of the problem" item, because in the "Problematic relationship" stress area those exposed to low risk are more predisposed to find solutions to problems; they show a different behavior, compared to male nurses with greater exposure, in the same item present in the "Personal attack" and "Personal devaluation" stress areas. Another significance among males we can note in correspondence with the "personal devaluation" stress area in relation to the "Emotional disadvantage" coping strategy, with low-risk subjects showing less emotional distress and therefore greater ability to manage their own emotions, compared to high-risk male colleagues. On the other hand, in the group of female nurses, the significances found show similar behaviors. Firstly, we refer to the greater need for social support by women exposed to low risk, compared to colleagues with

greater exposure, for the "Problematic relationship", "Personal attack" and "Personal devaluation" stress areas; secondly, in the same stress areas, we can find that nurses exposed to low risk show a lower ability to find adequate solutions to solve problems.

Table 11a. Mean ±SD of T-scores for coping areas and exposure risk, stratifying for educational status

Stress Areas	Coping Strategies	Stratum 1: Diploma		
		Low Risk	High Risk	Pooled sample
Clinical emergency	Social Support	42.00 ±6.00	47.36 ±9.75	46.41 ± 9.38
	Avoidance of the problem	46.67 ± 3.50	48.79 ± 10.30	48.41 ± 9.47
	Solution of the problem	44.33 ± 4.77	51.21 ± 9.98	50.00 ± 9.61
	Emotional Disadvantage	50.67 ± 5.29	47.50 ± 9.50	48.06 ± 8.94
Problematic relationships	Social Support	50.33 ± 3.04	49.86 ±10.13	49.94 ± 9.26
	Avoidance of the problem	49.67 ± 5.63	48.71 ± 9.04	48.88 ± 8.50
	Solution of the problem	40.67 ± 2.50	50.43 ± 9.45	48.71 ± 9.40
	Emotional Disadvantage	62.00 ± 0.03	49.00 ± 9.91	51.29 ± 10.27
Personal attack	Social Support	48.33 ± 6.14	47.43 ± 10.61	47.59 ± 9.93
	Avoidance of the problem	46.67 ± 5.77	49.93 ± 9.35	49.35 ± 8.87
	Solution of the problem	34.67 ± 2.50	52.29 ± 9.34	49.18 ± 10.89
	Emotional Disadvantage	54.67 ± 2.50	47.64 ± 8.22	48.88 ± 7.98
Personal devaluation	Social Support	49.67 ± 9.26	48.00 ± 7.44	48.29 ± 7.71
	Avoidance of the problem	52.00 ± 0.03	50.43 ± 9.35	50.71 ± 8.48
	Solution of the problem	40.00 ± 6.93	52.57 ± 7.32	50.35 ± 8.66
	Emotional Disadvantage	61.33 ± 3.50	48.57 ± 8.70	50.82 ± 9.39
Unexpected organizational events	Social Support	52.33 ± 4.00	50.00 ± 10.08	50.41 ± 9.31
	Avoidance of the problem	54.67 ± 10.11	50.21 ± 9.82	51.00 ± 9.92
	Solution of the problem	49.33 ± 4.00	50.57 ± 9.21	50.35 ± 8.51
	Emotional Disadvantage	58.00 ± 0.02	46.21 ± 7.65	48.29 ± 8.28
Stress Areas	**Coping Strategies**	**Stratum 2: Degree**		
Clinical emergency	Social Support	53.43 ±10.16	54.25 ± 6.66	53.61 ± 9.45
	Avoidance of the problem	51.36 ± 11.88	50.25 ± 5.59	51.1 ± 10.76
	Solution of the problem	51.29 ± 10.99	45.75 ± 7.29	50.06 ± 10.48
	Emotional Disadvantage	48.93 ± 8.52	62.25 ± 11.69	51.89 ± 10.76
Problematic relationships	Social Support	50.14 ± 10.97	50.25 ± 10.71	50.17 ± 10.81
	Avoidance of the problem	51.00 ± 11.51	51.25 ± 11.11	51.06 ± 11.32
	Solution of the problem	51.57 ± 11.89	50.25 ± 5.69	51.28 ± 10.79
	Emotional Disadvantage	47.57 ± 9.31	53.50 ± 10.92	48.89 ± 9.90
Personal attack	Social Support	52.50 ± 10.57	51.50 ± 7.76	52.28 ± 9.95
	Avoidance of the problem	49.00 ± 6.24	56.00 ± 20.08	50.56 ± 11.06
	Solution of the problem	49.43 ± 9.26	53.00 ± 9.05	50.22 ± 9.25
	Emotional Disadvantage	49.21 ± 8.71	56.75 ± 18.05	50.89 ± 11.67
Personal devaluation	Social Support	51.57 ± 12.17	50.25 ± 9.50	51.28 ± 11.56
	Avoidance of the problem	48.86 ± 11.06	52.00 ± 12.23	49.56 ± 11.29
	Solution of the problem	48.07 ± 12.05	54.00 ± 6.93	49.39 ± 11.34
	Emotional Disadvantage	47.14 ± 8.50	57.50 ± 12.65	49.44 ± 10.39
Unexpected organizational events	Social Support	49.93 ± 11.25	49.25 ± 10.40	49.78 ± 10.98
	Avoidance of the problem	48.64 ± 10.76	49.75 ± 5.55	48.89 ± 9.80
	Solution of the problem	51.07 ± 11.63	45.75 ± 8.69	49.89 ± 11.19
	Emotional Disadvantage	49.79 ± 9.175	57.75 ± 16.20	51.56 ± 11.44

Table 11b. Partial and combined p-values of comparison for exposure (low vs high) for each coping area, stratifying for educational status

Stress Areas	Coping Strategies	Diploma	Degree		Combined
Clinical emergency	Social Support	0.125	0.820	→	0.319
	Avoidance of the problem	0.586	0.774	→	0.794
	Solution of the problem	0.060	0.112	→	0.063
	Emotional Disadvantage	0.355	**0.001<**	→	**0.001**
Problematic relationships	Social Support	0.891	0.980	→	0.980
	Avoidance of the problem	0.762	0.979	→	0.951
	Solution of the problem	**0.005<**	0.731	→	**0.021**
	Emotional Disadvantage	**0.001>**	0.064	→	**0.004**
Personal attack	Social Support	0.830	0.784	→	0.925
	Avoidance of the problem	0.342	0.072	→	0.074
	Solution of the problem	**0.001<**	0.256	→	**0.003**
	Emotional Disadvantage	**0.014>**	**0.041<**	→	**0.004**
Personal devaluation	Social Support	0.627	0.731	→	0.781
	Avoidance of the problem	0.619	0.424	→	0.592
	Solution of the problem	**0.001<**	0.122	→	**0.001**
	Emotional Disadvantage	**0.001>**	**0.001<**	→	**0.001**
Unexpected organizational events	Social Support	0.581	0.906	→	0.844
	Avoidance of the problem	0.258	0.773	→	0.493
	Solution of the problem	0.751	0.160	→	0.353
	Emotional Disadvantage	**0.001>**	**0.037<**	→	**0.003**
		↓	↓		↓
Combined		**0.001**	**0.038**		**0.001**

A further analysis was carried out, within the group of nurses with diploma and degree, to evaluate the effect of the different risk exposure (Table 11). Among the nurses who have obtained a diploma, those exposed at low risk show a lower tendency, compared to their graduate colleagues, to solve problematic situations related to the "Problematic relationship", "Personal attack" and "Personal devaluation" stress areas. The same subjects show a greater tendency to strong emotional reactions, not only in the same stress areas, but also in "Unexpected organizational event" area.

Among graduates, except for the "Problematic relationship" stress area (in which no significant difference emerges between those exposed to the two risk levels), the only significance refers, for all other stress areas, to the "Emotional Disadvantage" coping area, in which the "<" verse indicates less emotional distress of those nursed exposed at low risk, compared to those who are exposed to high risk.

Table 12a. Mean ±SD of T-scores for coping areas and exposure risk, stratifying for ward

Stress Areas	Coping Strategies	Stratum 1: Neuromuscular Diseases		
		Low Risk	High Risk	Pooled sample
Clinical emergency	Social Support	54.25 ± 9.15	54.50 ± 9.45	54.40 ± 9.17
	Avoidance of the problem	45.25 ± 5.88	52.00 ± 11.55	49.30 ± 10.13
	Solution of the problem	45.50 ± 13.01	50.67 ± 10.01	48.60 ± 11.38
	Emotional Disadvantage	47.75 ± 6.94	56.83 ± 11.86	53.20 ± 11.01
Problematic relationships	Social Support	50.00 ± 10.93	53.67 ± 10.01	52.20 ± 10.36
	Avoidance of the problem	48.00 ± 5.67	51.83 ± 10.77	50.30 ± 9.15
	Solution of the problem	47.75 ± 6.78	50.67 ± 10.15	49.50 ± 8.94
	Emotional Disadvantage	45.25 ± 10.32	50.67 ± 5.96	48.50 ± 8.28
Personal attack	Social Support	54.00 ± 12.66	54.50 ± 4.55	54.30 ± 8.55
	Avoidance of the problem	47.25 ± 6.70	58.00 ± 17.46	53.70 ± 14.98
	Solution of the problem	50.50 ± 4.52	53.00 ± 11.88	52.00 ± 9.60
	Emotional Disadvantage	47.25 ± 6.28	54.00 ± 15.58	51.30 ± 12.99
Personal devaluation	Social Support	53.75 ± 9.50	53.17 ± 7.69	53.40 ±8.30
	Avoidance of the problem	41.00 ± 4.18	56.83 ± 12.20	50.50 ± 12.49
	Solution of the problem	50.00 ± 12.36	54.67 ± 5.66	52.80 ± 9.06
	Emotional Disadvantage	45.75 ± 8.53	53.50 ± 12.34	50.40 ± 11.48
Unexpected organizational events	Social Support	49.25 ± 10.40	56.17 ± 2.68	53.40 ± 7.56
	Avoidance of the problem	42.00 ± 15.67	53.33 ± 9.95	48.80 ± 13.53
	Solution of the problem	47.75 ± 12.10	49.17 ± 8.74	48.60 ± 10.04
	Emotional Disadvantage	50.00 ± 5.67	53.83 ± 15.23	52.30 ± 12.32
Stress Areas	**Coping Strategies**	**Stratum 2: Intensive Neurorehabilitation**		
Clinical emergency	Social Support	50.54 ± 10.81	46.08 ± 8.39	48.40 ± 9.92
	Avoidance of the problem	52.15 ± 11.73	47.67 ± 7.97	50.00 ± 10.28
	Solution of the problem	51.46 ± 9.32	49.67 ± 9.62	50.60 ± 9.44
	Emotional Disadvantage	49.69 ± 8.37	47.75 ± 10.49	48.76 ± 9.43
Problematic relationships	Social Support	50.23 ± 9.86	48.08 ± 9.85	49.20 ± 9.85
	Avoidance of the problem	51.62 ± 11.73	48.00 ± 8.66	49.88 ± 10.46
	Solution of the problem	50.23 ± 12.74	50.25 ± 8.05	50.24 ± 10.68
	Emotional Disadvantage	51.62 ± 9.66	49.67 ± 11.84	50.68 ± 10.74
Personal attack	Social Support	51.08 ± 9.13	45.25 ± 10.77	48.28 ± 10.30
	Avoidance of the problem	49.00 ± 6.03	47.92 ± 7.48	48.48 ± 6.74
	Solution of the problem	45.69 ± 11.17	52.17 ± 7.70	48.80 ± 10.14
	Emotional Disadvantage	51.08 ± 8.60	47.50 ± 8.44	49.36 ± 8.66
Personal devaluation	Social Support	50.46 ± 12.24	46.17 ± 7.00	48.40 ± 10.24
	Avoidance of the problem	52.00 ± 9.98	47.75 ± 7.03	49.96 ± 8.89
	Solution of the problem	45.62 ± 11.43	52.00 ± 7.77	48.68 ± 10.29
	Emotional Disadvantage	50.85 ± 9.62	49.08 ± 8.91	50.00 ± 9.27
Unexpected organizational events	Social Support	50.69 ± 10.46	46.67 ± 10.89	48.76 ± 10.79
	Avoidance of the problem	52.08 ± 7.61	48.50 ± 8.16	50.36 ± 8.03
	Solution of the problem	51.69 ± 10.19	49.67 ± 9.60	50.72 ± 9.90
	Emotional Disadvantage	51.62 ± 9.70	46.25 ± 7.36	49.04 ± 9.01

Table 12b. Partial and combined p-values of comparison for exposure (low vs high) for each coping area, stratifying for ward

Stress Areas	Coping Strategies	Neur. Dis.	Int. Neuror.		Combined
Clinical emergency	Social Support	0.912	0.053	→	0.191
	Avoidance of the problem	0.067	0.062	→	0.072
	Solution of the problem	0.218	0.411	→	0.300
	Emotional Disadvantage	**0.020<**	0.385	→	**0.043**
Problematic relationships	Social Support	0.360	0.355	→	0.386
	Avoidance of the problem	0.281	0.149	→	0.166
	Solution of the problem	0.414	0.959	→	0.758
	Emotional Disadvantage	0.088	0.440	→	0.153
Personal attack	Social Support	0.873	0.062	→	0.088
	Avoidance of the problem	0.055	0.496	→	0.120
	Solution of the problem	0.507	**0.005<**	→	**0.016**
	Emotional Disadvantage	0.173	0.078	→	0.066
Personal devaluation	Social Support	0.889	0.075	→	0.227
	Avoidance of the problem	**0.007<**	**0.041>**	→	**0.004**
	Solution of the problem	0.194	**0.006<**	→	**0.007**
	Emotional Disadvantage	0.074	0.445	→	0.135
Unexpected organizational events	Social Support	**0.015<**	0.111	→	**0.007**
	Avoidance of the problem	**0.025<**	0.061	→	**0.011**
	Solution of the problem	0.686	0.382	→	0.594
	Emotional Disadvantage	0.408	**0.010>**	→	**0.026**
		↓	↓		↓
Combined		**0.030**	**0.010**		**0.002**

Among nurses working in the "Neuromuscular Diseases" ward (Table 12), we note few significances that highlight that nurses exposed to low risk manifest less emotional distress than colleagues exposed to high risk in the "Clinical Emergency" stress area. Those exposed to low risk, compared to other colleagues, are less inclined to avoid problematic situations and rather try to face and solve them; this feature refers to the "Personal devaluation" and "Unexpected organizational events" stress areas. For the latter area, these nurses also show a lower need for social support. Among the nurses of the "Intensive Neurorehabilitation" ward we note that, in the "Personal attack" and "Personal devaluation" stress areas, those exposed to low risk are characterized by a lower tendency to face problematic situations; they, more than colleagues exposed to high risk, seek to avoid cognitive and behavioral problems in relation to "Personal devaluation" and, finally, have less emotional discomfort in correspondence with "Unexpected organizational events.

4. Discussion and Conclusion

The choice to carry out this study stems from the idea of understanding, through the HPSCS questionnaire, how much and who of the nurses working in the assistance to people with

Amyotrophic Lateral Sclerosis are subjected to the influence of stress and how they react, in this particular context, implementing different coping strategies.

These nurses perform their service activity, characterized by an emotionally strong relationship with patients who live in a critical, often dramatic, situation. Patients and even their families can convey problems, anxieties, worries, which inevitably spill over to healthcare personnel; all this derives from a need to be listened to and is amplified by a condition of break of a previous equilibrium that the disease caused. Continuous contact with the requests of patients and their caregivers can generate a state of chronic stress in nurses, which can also lead to emotional exhaustion.

The results obtained from the analysis of the sample show the total presence of an average level of stress, regardless of gender and educational status.

On the other hand, there are significant differences in stress levels in subjects classified according to the ward in which they operate, as well as a positive correlation between higher stress levels and the number of service years in nursing qualification, which has been appropriately taken into account by estimation of the risk index.

Finally, by using the NPC methodology, the area in which nurses are most stressed was identified; it is a personal sphere, because they state that they feel attacked (Personal Attack) and devalued (Personal Devaluation). On the other hand, with respect to the methods of reaction and coping with stressful situations, values above the average range are highlighted for the following coping strategies: "Solution of the Problem" and request for "Social Support".

In the past, the topic of "stress" or the "psychological breakdown" to which nurses are daily subjected has often been considered a taboo and a sign of weakness; today, however, this phenomenon is well known and represents the fulcrum around which numerous scientific researches and subsequent publications are performed. In this way, the professional who consults them becomes aware that he is not the only one to suffer from the negative psychological consequences related to his work and can find useful suggestions for implementing the appropriate coping strategies. On the other hand, effective intervention can also come from hospitals, that should take care to contain the occurrence of stress and fatigue through good planning of turnover.

This paper intends to provide added value to the existing literature, referring to the assessment of stress and the coping strategies implemented by nurses: in fact, there is no scientific contribution in which this kind of data (deriving from the administration of the HPSCS questionnaire) is analyzed by means of permutation tests and, specifically, by means of NPC

test. We underline the usefulness of this statistical tool that allows to perform stratified analyzes and to isolate potentially confounding factors.

The results of the present study may be precursors of further research that may affect the involvement of nurses operating in other wards characterized by potentially stressful situations, such as, for example, cancer wards.

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