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Low back pain characterized by muscle resistance and occupational factors associated with nursing

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Abstract
Objective: To identify the occupational factors associated with low back pain using a surveillance tool and to characterize the low back pain by the resistance of the extensor muscles of the vertebral column among nursing professionals at an Intensive Care Unit.
Methods: Cross-sectional study. The workers answered a questionnaire about occupational factors and participated in a resistance test of the extensor muscles of the vertebral column. Associations were established through Student's T-test or Mann-Whitney's U-test and correlations using Pearson's test.
Results: Out of 48 participants, 32 (67%) suffered from low pain. For the resistance test, the subjects suffering from low back pain endured less time in comparison with asymptomatic subjects, but without significant differences (p=0.147). The duration of the pain episode showed a significant negative correlation (p=0.016) with the results of the resistance test though. The main factors identified as causes of low back pain were biomechanical and postural elements, conditions of the muscle structure and physical and organizational conditions.
Conclusions: The main occupational factors associated with the low back pain were the posture and the characteristics of the physical and organizational conditions. In addition, the extensor muscles of the column showed a trend towards lesser resistance for workers in pain. This evidence is important when considering prevention and treatment strategies.

Keywords: intensive care units, nursing, low back pain, human engineering, physical endurance

Introduction
Low back pain (LBP) has been characterized as an ailment related to nursing staff (NS) in intensive care units (ICU) when analyzed from an ergonomic and functional point of view, due to exposure to occupational risks that contribute to LBP. However, the ergonomic risk factors related to LBP in NS have been less understood even though there is still a high prevalence of LBP symptoms [1-2].
The ICU poses important risks for NS in relation to the organization, the work environment and the social and professional relationship [2]. Moreover, the fact that the ICU areas have been earmarked for the care of volatile patients and more often even with risk of death [2], contributes to a correlation between stress and the appearance of cardiovascular, digestive, and musculoskeletal system symptoms for NS [3].
Among the causes of work-related LBP, individual factors (gender, age, stature, obesity, muscular strength related to the work requirements, endurance of the back musculature and smoking) and organizational factors (heavy, vigorous lifting movements, bending and twisting the vertebral column, vibration of the entire body, and work that is physically tiring) have been highlighted [4]. The most useful way to understand the occupational risks of LBP is based on the application of questionnaires related to the theory of the surveillance model [5], in which the detection of work factors that contribute to LBP are based on the declaration of the workers involved. Therefore, the study is based in the prior detection and management of musculoskeletal disorders related to work through the identification of musculoskeletal symptoms and risk factors which can contribute for the occurrence of the musculoskeletal disorders. In addition, this kind of multipronged effort will be effective for the best cost-benefit of the health care delivery personnel as well as the organisation, through an early detection of the problem for the prevention of musculoskeletal disorders [5]. As a result, the information obtained from the worker is more useful and specific for the detection of the problem and the early action for resolution [5].

This kind of questionnaire has been applied to health professionals [6] but it has not been applied to NS.

Additionally, there is a relationship between LBP and the reduced endurance of the extensor muscles of the vertebral column [7], as measured by the Biering-Sorensen test [8]. The lesser the time an individual sustains the test, the higher the probability of that individual being affected by an LBP episode [7]. Moreover, the NS have been subjected to the Biering-Sorensen test [9] and has shown to be a good example for the diagnosis and prognostic indicator for management and ergonomic adjustments in the work setup.

Thus, the study had the following objectives: to identify the work factors associated with LBP through the use of a surveillance tool, and characterize LBP by the endurance of spinal extensor muscles among female NS in the ICU.

Methods

A cross-sectional survey was conducted from October 2017 till September 2018 in adult ICU of IMS and SUM Hospital, Bhubaneswar. The inclusion criteria were female, posted full time in ICU for more than six months without any additional job engagements. The exclusion criteria were males, prior spine or pelvic surgery, pelvic inflammatory diseases, herniated disc, acute spinal infection, trauma, tumor or any other type of spinal neoplasm, LBP with symptoms of radiating pain, and pregnancy. The study was undertaken at the workplace, and all the NS gave their consent for the same.

The sample of this study was obtained through convenience sampling. In this way, all the subjects who complied with the inclusion criteria were invited to participate. Thus, of the 112 workers who work in the designated ICU, 48 (43%) accepted to participate in this study.

All the enrolled NS were appraised about the examinations they were being subjected to and were explained about the Biering-Sorensen test and the questionnaires applied. For the Biering-Sorensen test, they lied down in a prone position on the examination couch with the upper edge of their iliac crest in alignment with the edge of the table, and the lower part of their body was fixed to the examination table by three straps around the pelvis, knees, and ankle respectively [8]. Additionally, two parallel rods were aligned on both sides of the body, at the height of the seventh dorsal vertebra, and a cord linked to the rods remained over the subject's trunk to determine the tactile feedback [10]. During the test, the subjects with their arms folded across the chest, isometrically maintained the upper body in a horizontal position touching the tactile feedback cord, until they were exhausted. The endurance of theextensor muscles was determined by how long they could remain in this position. In subjects who had no difficulty in holding the position, the test was stopped after 240 seconds.

Subsequently, the result was measured by the Borg RPE Scale, on a scale from six to 20, with six indicating "no exertion at all" and 20 indicating "maximal exertion", and the reason for stopping the test was documented. The application of the Borg RPE Scale to the result was to ensure that the effort realized in the Biering-Sorensen test was appropriate. The workers received the questionnaire with questions about age, ethnic classification, role in the nursing team, description of principal activity, marital status, practice of domestic or sports activities, and the presence and characterization of LBP in the last year by the number of episodes per year, episode duration and the length of time since the last LBP episode. They also received an adapted questionnaire of work-related activities (QWRA) that may contribute to job-related pain and/or injury [11]. This questionnaire was used to identify 15 work-related factors, each factor contributed to the appearance of LBP by applying a score from zero to 10, with zero being "no problem" and 10 being "serious problem" for the occurrence of LBP, based on the theory of the surveillance model [5] and ergonomics [11]. All factors that were scored higher than two were considered as a positive contribution to the occurrence of LBP [12]. The scores were divided into three broad strata: zero to one as no problem related to that factor, two to seven as a minimal to moderate problem, and eight to 10 as an important problem related to that factor [12]. The factors evaluated were posture, work rhythm, organizational and environmental factors, and physical condition.

We analyzed the data using the SPSS statistical software version 16.0 and *Microsoft Office Excel Home and Student* 2007 software was used to produce the correlation ratio. The Kolmogorov-Smirnov test was applied to test the normality of distribution for the Sorensen test, the Borg Scale and the QWRA (Questionnaire of Work related activities that may contribute to job-related pain and/or injury). To evaluate the differences between individuals with LBP and those without, Student's T-test or the Mann-Whitney U-test were applied. The alpha value adopted was 0.05. Correlations were made with the variables 'episodes of LBP in the year', 'length of episodes of LBP', and 'most recent episode of LBP' with the result from the Biering-Sorensen test by applying Pearson's correlation coefficient or Spearman's correlation coefficient.

Results

Of the 112 nursing professionals approached, 48 (43%) subjects participated. They were: 16 (33%) registered nurses, 12 (25%) nursing technicians and 20 (42%) nursing assistants. Sixty-four (57%) subjects were excluded: men (n=36.56%), refusal to participate in the research (n=13.20%), being on leave or on holiday (n=7.11%), signs and/or symptoms described in the exclusion criteria (n=7.11%) and pregnancy (n=1.2%).

The mean age of the workers was 35 (sd=9.5) years and 38 (79%) were between 20 and 40 years old. The majority of the workers, 36 (75%), were Caucasian. There were 20 (42%) single, 21 (44%) married, and seven (14%) separated workers.

According to the statements on activities performed, all three categories (single, married and separated) performed activities involving direct care of critically ill patients and because of this, we analyzed all the workers together. There were 43 (89%) workers performing domestic activities and the majority of the participants (31 (64%)) did not participate in sports activities.

Workers affected by LBP (n=32, 67%)* reported a mean 57.7 (sd=105.4) LBP episodes during the year, with a median of 6.0 episodes (Table 1). Table 1 - Absolute, relative and accumulated frequency of LBP episodes per year of nursing professionals suffering from LBP pain (n=32.67%)*.

Table 1: Number of episodes absolute frequency and relative accumulated

Number of episodes per year	Absolute frequency of nursing professionals	Relative frequency (%)	Relative accumulated frequency (%)
1	2	6.4	6.4
2	1	3.2	9.6
3	5	16.2	25.8
4	3	9.8	35.6
5	3	9.8	45.4
6	3	9.8	55.2
10	2	6.4	61.6
12	2	6.4	68.0
30	1	3.2	71.2
40	2	6.4	77.6
100	2	6.4	84.0
150	1	3.2	87.2
200	1	3.2	90.4
300	1	3.2	93.6
360	2	6.4	100
Total	31	100	100

* One worker suffering from LBP did not declare the number of episodes per year

In relation to the factors that could cause LBP, both groups showed similar opinions, with no significant difference (Mann-Whitney U-test, p-value varied between 0.062 and 0.982) between the groups. Accordingly, the workers were grouped into a single analysis of the factors.

The principal factors identified as causing LBP were related to biomechanical and postural elements, conditions of the muscular structure, and physical and organizational conditions. These factors presented average values of greater than or near 8.0, with a higher concentration of responses in the third column of Table 2. Subsequently, the factors that were grouped in the range from two to seven were "working without receiving training", "working in a hot, cold, humid or wet environment" and "using tools (shape, weight, vibration, etc.)". The average value for these factors was between 4.39 and 5.64. Finally, the only factor that obtained a maximum number of marks in the band of zero to one was "having to handle or hold small objects". Thus, this factor was considered not to contribute to the appearance of LBP.

Discussion

This study demonstrated that a surveillance tool is an effective method to distinguish the stress factors associated with LBP in NS staff in the ICU, as all factors outlined are consistent with the literature and all workers, with or without LBP, have the same opinion about the risks. Moreover, the endurance of the extensor muscles of the vertebral column showed a predisposition towards less resistance for workers with LBP in comparison to workers without LBP, especially when the duration of the LBP episode was longer, and this authentication is important when preventive strategies are considered.

The LBP episode is a reality for the nursing working and Brazilian [3, 13] and international [1] studies reinforce this idea. However, the approach undertaken in this study showed its novel nature, as there were no studies that combined the instruments selected which enable the characterisation of the research in a broader sense.

To ensure a strong methodology, we included only women in our study because there are differences between the musculature vertebral column endurance in men and women. Men have shown to be less resistant compared to women, because of variations in the morphology of the lumbar tissues relative to the proportion of type 1 and type 2 fibers [14]. If we had not made this choice, the characterization of the workers by muscle resistance would be biased. On the other hand, we did not perform a sample calculation. Our sample was by convenience and we observed great variability in some variables. Because of this, we could not discard the possibility of a type II error. The characteristics of workers selected ensured that we selected a group of LBP risk. The age of workers who participated in our study belonged to a young group and who have shown a higher percentage of pain in the vertebral region [15]. Additionally, the majority of workers involved in this study performed domestic chores as well, which associated with bad posture during domestic activities, coupled with professional activity, can increase the probability of LBP [16]. Moreover, we found a lesser number of workers who participated in sporting activities, and considering that sports activities would be an important factor in LBP prevention [17], this factor could contribute to the appearance of LBP. We categorized the workers in the LBP and non-LBP groups by self cofession and this could be a limitation because the workers might have hesitated reporting their symptoms appropriately out of fear of shunting, losing their job, reprisal, and believing pain to be an expected consequence of work and age [18]. It is known that the Biering-Sorensen test is affected by individual factors such

as motivation, tolerance, pain, fear and competitiveness [10], so in addition we used the Borg RPE Scale and the tactile feedbackto evaluate the fatigue in the execution of the test and, thus, to ensure its reproducibility [10, 19]. It is important to observe here that the majority of LBP workers who participated claimed to have taken the endurance test during a pain-free period. We did not take into account the psychological factors and their contribution to LBP but recent studies show association between LBP and psychological factors [20], and we suggest that future research should investigate this variable.

The time in the Biering-Sorensen test was on average 93.06 seconds for LBP workers, which was similar to the values found in other studies [21]. For the asymptomatic workers however, the time found in the present study (116.3 seconds) was less than in another study [21], in which the time was 220 seconds. Nevertheless, we could classify our asymptomatic workers as 'best performance' and those with LBP as "average performance' [7]. Therefore, despite no significant differences between our groups of workers, literature research and the present results, we can say that there exists a trend towards less endurance of the extensor muscles in individuals with symptoms of LBP. The results of the Biering-Sorensen test were effective because all workers who performed the test reached an intense effort [15] on the Borg Scale, which has shown good sensitivity and reliability to evaluate intensive effort among healthy persons and those with LBP [19]. Furthermore, the main reason to finish the test revealed symptoms of fatigue, which strengthened the quality of the results. Moreover, the use of the Biering-Sorensen test is valid because the test utilizes the individuals' own body weight to create the postural resistance. Thus, the strength of the individuals is reasonably related with their body weight, and the load offered to the individuals tested is proportional to their vitality most of the time [22]. The correlation between the average duration of an episode of LBP and the Biering-Sorensen test time showed that, the longer the duration of the lumbar episode, the shorter the time achieved in the Sorensen test and, consequently, the lesser the endurance of the low back extensor muscles. We did not find any studies in the literature that correlated these two characteristics and further research, especially longitudinal studies, are needed to confirm the occurrence of this behavior, and to better understand the contribution of muscle resistance and appearance of LBP.

All workers associated the same factors that contributed to the appearance of LBP as posture, physical condition and organizational characteristics. Mobilising patients, bending and twisting the vertebral column, repetitive movements caused by the constant changes in the lying position of patients, handling loads, difficulty reaching objects and the lack of space around the bed caused by the quantity of equipment present, and obliging the NS to assume a poor posture in their activities, established the causal factors for LBP pain [2, 17, 23], and thus reflected the opinions indicated by the workers surveyed in this study. Working when one has some injury or pain was mentioned by the workers as a cause of LBP. In addition, working with an injury or symptoms of pain also jeopardized the quality of the services provided and promotes limitation in productivity of about 4.87% [24]. In terms of organizational issues, the rhythm of work in ICUs, such as the speed with which tasks are completed and the long shifts with lack of breaks for relaxing in the normal work day of NS are evidence found in the literature that contributes to LBP [25]. Thus, they are in consonance with the subjective impressions given by the workers in the present research. This research indicated a minimum or moderate association between factors related to working without prior training and in an uncomfortable environment and the characteristics of tools and the appearance of LBP. It is known that, while training related to care and procedures is offered to nursing professionals in ICUs, there is a lack of training focusing on the recognition of the health risks in performing their activities and injury prevention [2]. Such training is important to prevent LBP, and the training has to be accompanied by structural changes and the use of technological apparatus to be successful in the treatment and prevention of LBP [23]. Although no studies were found in the literature evaluating the role of temperature factors in the appearance of LBP in ICU NS, the exposure of a part or all of the body to the cold may be a contributing factor in the appearance of musculoskeletal disorders in the lumbar column [26]. Therefore, future research should be undertaken to better understand how this relationship would contribute to the appearance of LBP in these professionals.

Conclusion

Universally, LBP appears to be associated with a wide variety of causative elements, such as environmental, biomechanical, organizational, personal, genetic, psychosocial, physiological and financial factors in ICU nursing professionals and these relationships validate the findings in our study. Proper distribution of work through ergonomic studies is essential to improve the work culture and to prevent LBP among NS. Thus, the application of surveillance tools is very useful because they are easy to apply, raise the opinions of workers, direct the ergonomic changes, evaluate the interventions and are reproducible too. Moreover, the inclination towards less endurance of spinal extensor muscles being associated with LBP warrants the urgency to scrutinize the physical conditions of workers and the execution of spinal exercises for the proper diagnosis and prevention of LBP, but this hypotheses needs to be better investigated. Therefore, the outcome of this study adds relevant information to the areas of worker health, physiotherapy and nursing, and we believe that our results will promote projects aimed at the treatment, prevention and protection of NS in ICUs.

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