Characterizing Musculoskeletal Disorders. A Case Study Involving Kindergarten Employees

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Abstract. This article presents the results of applying the Nordic Kuorinka questionnaire in a group of educators to infer musculoskeletal healthiness. The Kuorinka instrument queries the workers about postural pains and muscular afflictions that might have appeared due to systematic effort in the workplace. The sample, n = 42, included administrative workers, teachers, general services members, and kitchen individuals a kindergarten. These people execute different activities with diverse workloads. The results show that individuals with general discomfort in the last 12 months pointed at the neck as the source of the problem. In 19% of the workers, the discomfort lasted around 30 days, but the employees decided not to report the health-related event to the human resources office. 25% of the participants indicate that each episode of pain or discomfort lasted from one to four weeks. Other results indicate that among the workers incapacitated for 1 to 7 days, only 17% received medical treatment. According to Liberty Mutual, the largest workers' compensation insurance provider in the United States, musculoskeletal diseases cost employers 13.4 billion every year the United States. Nevertheless, and perhaps more disturbing is that workers do not use the health systems after work-related discomforts. Also, corrective actions are few or non-existent in Latin American countries, perpetuating work-related diseases and increasing the burden of losing health and productivity.

Keywords: Work related injuries · Ergonomics in preschool teachers · Musculoskeletal discomfort

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1 Introduction

Musculoskeletal disorders (MSD) originated by work impact employees' health and precluded their capacity to work in all economic sectors. Authors in diverse countries have studied the topic along with the evolution of occupational safety and health. An excellent example of the subject's relevance happened in Colombia between 2001–2002 when the general direction of occupational risks attached to the Ministry of Social Protection evidenced carpal tunnel syndrome as the leading cause of occupational disease. Likewise, lumbar pain, painful shoulder syndrome, Quervain's tenosynovitis, medial and lateral epicondylitis, and herniated discs increased during 2003 and 2004. In 2007 – also in Colombia – the results of the first national survey of health and work conditions in the general system of occupational risks claimed that agents with the highest exposure to positional conditions during work were related to ergonomic conditions. Those positional conditions include but are not limited to non-natural movements, repetitive tasks, keeping posture for extended periods, and lifting or moving heavy loads without mechanical assistance [16].

In the United States – 1995 – a study evidenced the annoyances of educators in a Montessori school, indicating that these are related to actions such as kneeling, sitting on the floor, squatting or bending at waist level. The operators performed these actions while cleaning, note-taking, serving food, executing bathroom activities, and direct work with children [9].

In another study, researchers identified some problems that were considered generalizable in these work settings. Among these are the incorrect lifting of children, toys, and materials by workers; the inadequate height of work tables, sitting on the floor without support on the back, reaching above the shoulders, making sudden movements combined with awkward postures when lifting objects, carrying garbage bags [11].

The authors in [10] coincide with previous claims saying that physical demands such as feeding children, changing diapers, providing learning activities, lifting and carrying children and materials, lowering and raising children in chairs, squatting to interact with children, and moving furniture, among several others, put workers of the studied sector in muscular discomfort.

In the study named Prevalence and risk factors of neck pain and pain in the upper extremities among school teachers in Hong Kong, researchers highlighted that working head down constitutes a risk factor for neck and upper limb pain (69.3%). The same study in Brazil yielded 41.1% of primary and secondary teachers who reported back pain associated with the workload and the positional constraints within the workplace [2,4].

Finally, in Colombia, in the study of Osteomuscular Pain in Teachers of an Educational Institution for Technical and Technological Training, it was shown that 65% of teachers had musculoskeletal pain in the last year due to executing work-related activities [17].

These antecedents suggest that MSD and sequelae are a silent pandemic; therefore, our interest investigating the subject in different environments. In this opportunity, we provide insights into the problem in a kindergarten, aiming

to identify the sources MSD and associated discomfort suffered by the staff. In further deliveries of this project, we will provide scientifically-based mitigation strategies.

2 Materials and Methods

2.1 Evalu@ Parametrization

To promptly deliver the questionnaire to several people and yet, make the querying tool available for continuous data gathering even out of the scope of the current exploration, we employed the on-cloud data centralizer Evalu@ http://www.evalualos.com/test/. The Fig. 1, shows a section of the configuration file used and the part of the web form created by the system.

2.2 The Kuourika Questionnaire (KQ) Administration

The Nordic KQ is a standardized instrument for the analysis of musculoskeletal symptoms in the workplace [14].

The questionnaire can be administered as part of an interview or in a self-administered format. The questionnaire evaluates the neck, shoulder, thoracic spine, elbow, hand/wrist, and lumbar spine, aiming to identify the annoyances in the early stages and thus, improving well-being in people and working conditions.

Considering the characteristics of the questionnaire described above, we guide each of the 42 participants in accessing the Evalu@ tool application for handheld devices. Once we ended the training, each worker fulfilled the 11 main questions of the Nordic questionnaire taking five minutes on average in a self-administered manner. In Evalu@, 462 yes/no answers were obtained, characterizing the annoyances of the kindergarten workers [18].

3 Results

3.1 Discomfort in the Upper Body

A total of 42 questionnaires were processed using the Evalu@ tool. An overview of the results showed that 58% of the workers evaluated presented some discomfort. Among the 42 workers, 40% rated the annoyance with a rating of 4; on the scale, zero (0) is without annoyance, and five (5) is very strong. Among the employees suffering pain, 28% pointed at activities not associated with their work as the annoyance's origin.

In the detailed results, starting with the discomfort presented in the upper part of the body, it is evidenced that 58% of the workers have had neck discomfort. The previous percentage coincides with the general result, which indicates that the same percentage of workers have had at least one of the listed sources of discomfort. In their order, the next affectation in the upper part of the body is the wrist, with 46%. Finally, 42% of the workers presented discomfort in the lumbar spine. (See Table 1).

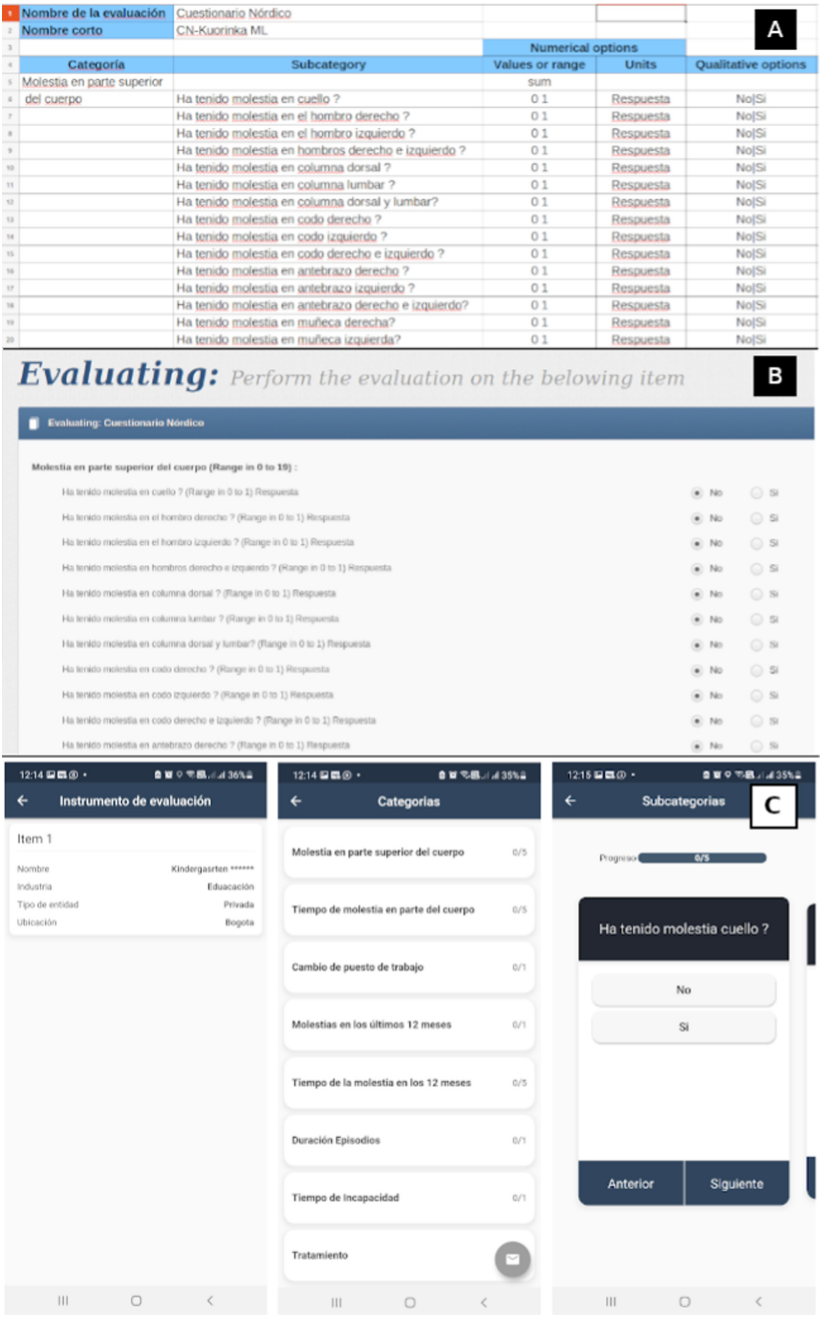

Fig. 1. In panel A, the top part of the excel file to teach Evalu@ how to perform the Kuorinka Questionaire. In panel B, the tracking instrument ready for web usage. In panel C, the cell phone interfaces that are synchronized in real-time and allow the final users to register the data from any place in the world. The configuring forms follow the official language spoken at the studied institution.

Table 1. Upper body most affected joints

No.	Subcategory	Rating in points	Max	Min	Std	Percentage
1.1	Have you had neck discomfort?	0.58 in [0,1]	1.0	0.0	0.49	58%
1.14	Have you had discomfort in your right wrist?	0.46 in [0,1]	1.0	0.0	0.50	46%
1.6	Have you had lumbar spine discomfort?	0.42 in [0,1]	1.0	0.0	0.49	42%

3.2 Analysing Discomfort by Upper Body Joint

When analyzing the discomforts' longevity, 20% of the workers referred that they had between 6 and 10 years of displeasure. 19% of the studied population complained of lumbar spine pain-16% of individuals reported between 6 and 10 years of pain in the right wrist. See records on Table 2. Although none of these results indicate affectation close to 50% of the population, it is essential to consider that the symptoms of pain or discomfort lead to severe long-term afflictions. Therefore, the generation of mitigation strategies is of utmost relevance to lengthen the productive life of the employees and reduce costs associated with the diagnosis, treatment, and prognosis of patients with work-related diseases.

Table 2. Time of discomfort by joint

No.	Subcategory	Rating in points	Max	Min	Std	Percentage
2.1	How long have you had neck discomfort?	0.81 in [0,4]	4.0	0.0	0.91	20%
2.6	How long have you had lumbar spine discomfort?	0.75 in [0,4]	4.0	0.0	1.02	19%
2.14	How long have you had the discomfort in your right wrist?	0.64 in [0,4]	3.0	0.0	0.90	16%
2.5	How long have you had spinal column discomfort?	0.54 in [0,4]	4.0	0.0	0.87	14%
2.17	How long have you had the discomfort in your right hand?	0.56 in [0,4]]	4.0	0.0	0.89	14%
2.7	How long have you had back and lumbar spine discomfort?	0.56 in [0,4]	4.0	0.0	1.00	14%

3.3 General Discomfort Timing in the Last 12 Months

The discomfort in the last 12 months and the hardship category in the upper part of the body yielded similar results (see Table 3). The pain in the neck was the most frequently reported affliction going up to 58% of the workers' population studied.

Table 3. General discomfort in the past 12 months

No.	Subcategory	Rating in points	Max	Min	Std	Percentage
4.1	You have had discomfort in the last 12 months?	0.58 en [0,1]	1.0	0.0	0.49	58%

Regarding discomfort in the last 12 months (see Table 4), 19% of the workers reported non-continuous pain for more than 30 days. 20% indicated discomfort in the lumbar spine, and 17% reported non-continuous discomfort in the dorsal and lumbar spine for more than 30 days. It is essential to mention that the discomfort in the right wrist has not occurred in the last 12 months among the studied population. The discomfort in the dorsal and lumbar spine is more relevant than the discomfort in the right wrist.

3.4 Upper Body Discomfort Timing in the Last 12 Months

Table 4. Localized discomfort timing in the last 12 months

No.	Subcategory	Rating in points	Max	Min	Std	Percentage
5.6	How long have you had lumbar spine discomfort in the last 12 months?	0.81 in [0,4]	4.0	0.0	1.14	20%
5.1	How long have you had neck discomfort in the last 12 months?	0.75 in [0,4]	4.0	0.0	0.93	19%
5.7	How long have you had discomfort in the last 12 months in the thoracic and lumbar spine?	0.66 in [0,4]	0.0	1.10	0.90	17%
5.17	How long have you had discomfort in the last 12 months on your right hand?	0.59 in [0,4]	4.0	0.0	0.99	15%
5.5	How long have you had back discomfort in the last 12 months?	0.54 in [0,4]]	4.0	0.0	1.03	14%

3.5 Discomfort in the Last Seven Days

Regarding having discomfort in the last seven days (see Table 5), 34% of the workers indicated the neck as the source of displeasure. This same percentage of workers have presented discomfort in the lumbar spine. 29% presented discomfort in the thoracic spine; and 24% in the dorsal and lumbar spine.

Table 5. Discomfort in the last 7 days

No.	Subcategory	Rating in points	Max	Min	Std	Percentage
9.1	Suffered neck discomfort in the last 7 days?	0.34 in [0,4]	1.0	0.0	0.47	34%
9.6	Suffered lumbar discomfort in the last 7 days?	0.34 en [0,1]	1.0	0.0	0.47	34%
9.5	Suffered thoracic spine discomfort in the last 7 days?	0.29 in [0,1]	1.0	0.0	0.45	29%
9.17	Suffered right hand discomfort in the last 7 days?	0.24 in [0,1]	1.0	0.0	0.43	24%
9.7	Suffered discomfort thoracic and lumbar spines in the last 7 days?	0.24 in [0,1]	1.0	0.0	0.43	24%

3.6 Duration of the Discomfort Episodes

The duration of the episodes in the study population coincides with the previous categories in terms of neck discomfort (see Table 6). A 25% of workers in the study indicated that the episode of neck discomfort lasted from one to four weeks. Also, 23% of the studied population reported episodes of discomfort in the right hand lasting from one to four weeks. Finally, 20% of the workers reported discomfort in the right hand and wrist lasting from one to four weeks.

Table 6. Duration of episodes

No.	Subcategory	Rating in points	Max	Min	Std	Percentage
6.1	How long is each episode in the neck?	1.27 in [0,5]	5.0	0.0	1.38	25%
6.17	How long is each episode on the right hand?	1.14 in [0,5]	5.0	0.0	1.51	23%
6.6	How long does each episode in the lumbar spine last?	1.00 in [0,5]	4.0	0.0	1.30	20%
6.14	How long is each episode on the right wrist?	1.02 in [0,5]	5.0	0.0	1.46	20%

Of high significance, no worker reported pain episodes lasting more than a month. Additionally, none of the episodes lasted less than an hour. Only 6% of the workers were incapacitated, indicating that the period of incapacity lasted from 1 to 7 days. 40% of the studied population assigned a level of four (4) to the qualification of the annoyance in the scale zero (0) without annoyance and five (5) very strong annoyances; 28% of the population defined activities other than work and sports activities as the cause of their discomfort. As for receiving treatment, only 17% of workers have received any intervention for these complaints. Although the disability does not necessarily indicate that the worker requires a specific treatment, it is necessary to clarify that rest (not treatment) is a valid alternative intervention. Finally, 7% of the population refers that it has been necessary to change their job.

3.7 Annoyance Vs. Disability Time

Regardless of the moments in which the discomfort occurs, the workers did not go to a medical service; see Figure . Recall that this study pointed to disability time in two-time schemes of discomfort – twelve months and seven days –, showing that the annoyance persisted without being attended-the Figures and present evidence for the mentioned reluctance to visit the health providers.

Regarding the time of disability versus the discomfort's presence in 12 months, In Fig. 2 although 58% of the workers reported displeasure only 6% received medical attention.

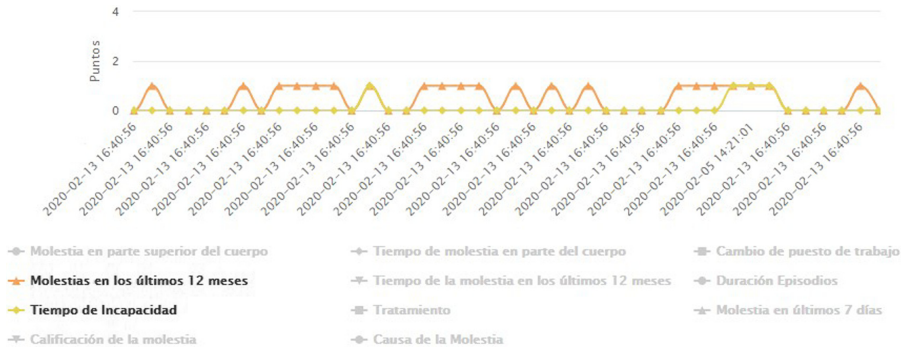

Fig. 2. The discomfort remains without receiving medical attention. Only a small part of the working population made the medical consultation.

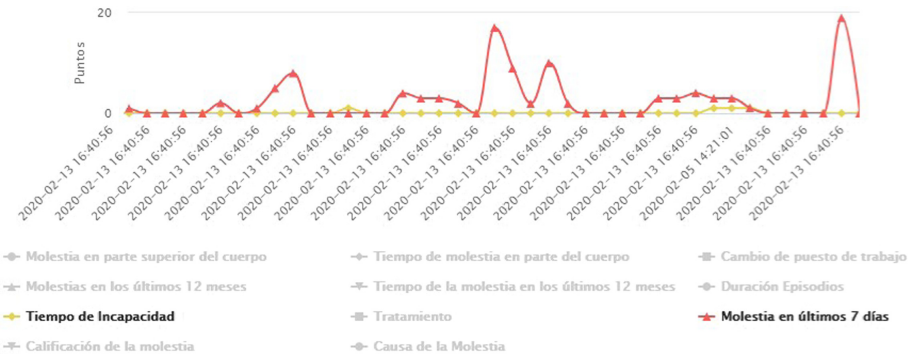

Fig. 3. As the previous graph, the worker continues in his activities even with discomfort.

In the case of discomfort in the last seven days vs. Time of disability, In Fig. 3 indicates that the workers, although presenting the discomfort, did not visit the doctor. In this sense, the workers tend to continue their work even while suffering pain.

Fig. 4. The red line indicates that the discomfort was more acute in the last seven days, compared to the last 12 months. However the annoyance persists. (Color figure online)

Regarding Discomfort in the last twelve months versus Discomfort in the last seven days, the Fig. 4 shows steeper curves in the last one compared to the former. Such findings suggest that discomfort has lasted over time and that the feeling of discomfort is more acute when the worker has answered the questionnaire. As for the hardship in the last 12 months, it is crucial to note that episodes lasted between one and four weeks, suggesting that soreness appears and disappears. In the case of reappearance, the discomfort is not similar in intensity and nature to the original.

4 Discussion

Several authors claim that kindergarten teachers would suffer pain and discomfort originating in the body's upper part. At the same time, people who work in nurseries and caring activities suffer mainly from the back's lumbar region. In this study, the back's lumbar region was the third most affected part of the body with 42%, after neck and wrist discomfort.

Although lumbar discomfort occurs in the population studied as indicated by other authors, it is advisable to study – in-depth – the exposure times in the actions in which the movements and postures associated with this discomfort are involved. For example, in the study by Grant *et al.* [9] in teachers sitting in tiny chairs, kyphosis was evidenced in the lumbar spine. For example, at the time of serving food, a worker could be observed flexing and straightening four times a minute to serve or clean in positions of 45 to 90 degrees.

A detailed postural analysis is considered an essential resource in the study of kindergarten activities.

As stated by Punnet [15], the measurement of the work cycle, the time taken in each position, and the time that the actions last within the cycle, are variables to take into account for future evaluation proposals.

The types of postures assumed by the workers are related to the activities and gestures learn during childhood and later through adaptation. As reported Kumagai [13], in activities with children from 0 to 1 years, the most frequent postures were "sitting on the floor" and "kneeling," while in activities with children from 4 to 5 years, the most frequent postures were "standing" and "sitting in a chair." In the study above, he draws attention to the non-neutral postures, indicating that 35% of the shift time was employed in postures such as standing, leaning forward, squatting, and kneeling, considering that these postures caused a load on the lower back.

In this sense, it is pertinent to inquire about the population of workers that in this study remained standing or sitting with discomfort.

Since the neck is a sensible part of the human body, we studied it separately from the shoulder, obtaining 58% of workers with discomfort in this part of the body. The finding coincides with the total number of workers who had presented discomfort in any upper body regions: neck, shoulder, spine, elbow, hand/wrist, or lumbar spine. In the reviewed studies, reports of discomfort in this part of the body are evidenced in secondary school teachers more than preschool teachers.

In the study carried out by Chiu *et al.* [4], 69.3% reported neck pain in secondary school teachers. Other studies indicate the same results exceeding 50% of the population. In the study carried out by Chong*et al.* [5], 68.9% had neck pain, and in the study carried out by Korkmaz*et al.* [12] 42.5% of neck pain was reported in male and female teachers. Similar results to those obtained in this study were shown by Damayanti *et al.* [7] , indicating that neck pain occurred in 53.52% of the respondents.

Regarding neck discomfort, it is vital to indicate that the symptoms may persist even after diagnosis. In the study by Converso [6], 75.6% of diagnosed workers (238) reported neck pain even while being treated.

Given that in this population of workers, 58% of them presented neck discomfort. We suggest two postural aspects to consider in later studies and mitigation strategies to apply in kindergartens. The first is the use of a "head down" posture; the second referring to the posture of "pushing the chin" both associated with neck pain, reported in the study by Chiu *et al.* [4].

Regarding the discomfort in the right wrist, in contrast to the results obtained in this study, Grant *et al.* [9] evidenced discomfort in 11%, while Korkmaz et al. (2010) reported 13.4%. Erik *et al.* [8] reported 30.7% discomfort. Although these results are well below those obtained in the present study, it is necessary to consider the specific activities performed by kindergarten workers, including extension, abduction, and wrist adduction. Also, the posture assumed by the teachers and the exposure time when carrying out the writing activities, given that the teachers write and describe the tasks and the observable advances in the children's development daily.

As for the discomfort in the last 12 months, our experiments yielded numbers above the findings of Alias [1], who stated the neck discomfort affliction in 22.6% and 22.2% for male and female teachers, respectively. Our results in this regard are similar to the ones obtained by Erick [8] claiming that neck discomfort affects 50.8% of teachers.

Concerning the discomfort category in the last seven days, 34% of the teachers had neck discomfort and 29% in the spine. Alias [1] reported that teachers suffer pain, 22.2% in the neck, 27.4% in the back, and 26.4% in the lower back.

In results obtained in research similar to this study, cheng [3] showed that 16.1% of workers had neck discomfort greater than 30 days and 14.2% of workers presented lumbar spine discomfort greater than 30 days.

Regarding the right wrist, in the present study the workers did not present discomfort in the last 12 months, which coincides with the study by cheng [3]. However, they pointed out that when these episodes occur, they last from one to four weeks in 23% of them, which indicates again the relevance of carrying out a detailed analysis of the movements of the right wrist, the exposure time and the tasks in which these movements are executed.

Concerning disabilities, cheng [3] showed that 19.4% caused sick leave, while in this study, only 6% were incapacitated for 1 to 7 days. Similarly, cheng [3] recorded 25% suggestions for work changing in contrast to 7% of workers considering work change in the current work. The reasons for the workers to continue carrying out their work despite the discomforts might be diverse. Since the

Kuorinka test does not provide mechanisms to discern this question, we might slightly modify the test to gain the required resolution and deliver responses to this and other crucial details.

Regarding the above, Damayanti [7], reported 17.7% of teachers visiting the doctor due to neck and shoulder discomfort; whereas, 22.3% did visit the doctor complaining in back discomfort. In the present study, 17% of the teachers have received some intervention to their discomfort.

The data used to derive the results presented in this work were gathered by Evalu@, which enables the constant monitoring of variables, accessible data capturing (by computer or handheld devices), and the rapid management of the information, facilitating the analysis. The data gathered in the kindergarten is still available as a baseline to support intrinsic monitoring and interinstitutional analysis.

5 Conclusion

This study presents the discomfort analysis in teachers of a Kindergarten. The affected regions in their order were: neck, wrist, and lumbar spine. The analysis corroborated some of the findings presented by other authors in similar methodologic approaches. Nevertheless, the studied subjects switched the incidence of discomfort per body zone, being the neck the most prevalent source of pain. Although already reported as a significant finding, the workers' reluctance to visit the health care system was not as marginal as this investigation present it. The objection to visiting the health care providers and, thus, unfeasibility to threatening the work-related discomforts enlights substantial flaws in the risk management systems. Consequently, we may venture into predicting a significant number of current employees falling into chronic afflictions that considerably and progressively deteriorate the quality of life. Further work involves increasing the sample by diagnosing other companies and using the artificial-intelligence-based prediction capabilities offered by Evalu@ to sensibilize companies and the risk management entities.

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