

## Work-related musculoskeletal disorders in home care nurses: study of the main risk factors

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### Abstract

**BACKGROUND:** Nurses are a risk group for work-related musculoskeletal disorders (WMSDs). Several studies reveal that nurses have high prevalence rates of injuries and symptoms related to WMSDs. However, many of these studies focus mostly on hospital nurses. Worldwide, few studies include home care nurses.

**OBJECTIVE:** This work aimed to identify the body region most affected by musculoskeletal complaints in home care nursing, and subsequently develop a statistical model, that includes the main risk factors, to predict the risk of having musculoskeletal complaints in the identified region, .

**METHODS:** The research method was based on the Standardised Nordic Questionnaire applied to home care nurses working at Health Centres of northern Portugal. Univariate and multivariate models of logistic regression were used to meet the goals of this work.

**RESULTS:** Home care nurses have a three times greater chance of having lumbar complaints than their counterparts working only at Health Centres

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(OR=3.19 ( $p<0.05$ ), with a 95% confidence interval [1.256; 8.076]). A statistical model with seven variables (forearm posture; static postures; arm posture; arm supported; bed height; job satisfaction; assistive devices) was obtained to predict lumbar complaints.

**CONCLUSIONS:** The lumbar region was identified as the most affected by musculoskeletal complaints. These complaints were associated with seven factors.

**Keywords:** musculoskeletal disorders, lumbar region, home care nursing, Health Centres, predictive model

## 1. Introduction

Work-related musculoskeletal disorders (WMSDs) have been described as the most important occupational health problem affecting nurses [1,2]. The high prevalence rates of musculoskeletal symptoms and injuries in nurses confirm this claim [1,3-10]. In fact, caring for people is considered a risky activity by some authors, as it is associated with high prevalence of musculoskeletal complaints, mainly in the back [1,3,4,6,11]. It is very important to reduce back complaints in nurses as those may lead to physical suffering, greater absenteeism, and also to an early retirement. Also, symptoms in the lumbar region can lead to symptoms in other body regions [6].

Most studies about this topic have been carried out in hospitals, nursing homes and other institutions. Information regarding WMSDs in home care nurses worldwide is scarce [12]. Still, there are few studies dedicated to WMSDs in nurses, especially comparing nurses in home care with nurses in hospitals and nursing homes.

Some studies indicate that injuries and musculoskeletal disorders in the back and other body sites constitute a serious problem for professionals who provide home care, namely nurses and nursing assistants [13-18]. A study involving a comparative analysis of musculoskeletal disorders between Greek and Dutch nursing personnel in hospitals and nursing homes suggested that work in both situations entailed similar risks. However, the nursing home environment may entail more risks, as is less controlled and standardised [3]. Following that reasoning, one can suppose that home care provision may lead to an even higher risk since patients' homes are an even less controlled work environment without any pattern [19]. Home care nursing has specific characteristics, such as cramped spaces, misfit working surfaces (too high or too low), inappropriate furniture, and other adverse working conditions that may determine the adoption of risk behaviours [20]. According to Szeto et al. [21], due to the restrictive environment found in patients' homes, home care nurses often have to work in awkward postures.

However, a study reported that there is less risk of WMSDs for nurses that provide home care when compared with those working in hospitals or nursing homes [22]. That study compared nursing staff from seven European countries and from different institutions (hospitals, nursing homes, and home care providers) to evaluate their exposure to physical and psychosocial risk factors associated with disabilities related to back or neck pain. These two risk factors were less found in home settings. Kromark et al. [23] obtained similar results. A study comparing nursing staff from nursing homes and nurses from home care revealed that the first reported disorders in the cervical or lumbar region more often.

Due to the scarcity of studies and information on WMSDs in home care nurses, this paper aims to provide information on WMSDs and related complaints regarding home care nurses working in Health Centres of northern Portugal. The objectives of this study were to identify the body region most affected by musculoskeletal complaints in the practice of home care nursing, as well as to develop a statistical model including the main risk factors to predict the risk of having musculoskeletal complaints in the identified body region.

## **2. Materials and methods**

### **2.1 Questionnaire**

The authors developed an electronic questionnaire to gather the information for the study and tested it previously in a specific group of nurses. The questionnaire [24] was based on the Standardised Nordic Questionnaire (SNQ) [25] for the analysis of musculoskeletal symptoms. The SNQ is one of the most used self-assessment questionnaires for the characterisation of WMSDs. Several questions were added to allow collecting more information, applying statistical techniques for identifying the largest possible number of WMSD risk factors, and evaluating their impact on the appearance of musculoskeletal complaints. The adjustments and the new questions specifically addressed to home care nurses are described below. The complaints and symptoms collected by the questionnaire were analysed to identify risk factors for WMSDs since they are a good predictor of subsequent WMSDs [26].

In Primary Health Care there are nurses that only provide care in Health Centres and others that additionally provide home care nursing. The home care nurses

had to answer a total of 105 questions, while those not providing home care only had to answer 59 questions.

The questionnaire was divided into four parts, as described by Carneiro et al. [27]. Parts A and B are an adaptation of the Standardised Nordic Questionnaire [25], while parts C and D only include questions related to tasks developed in patients' homes. Part A includes demographic and professional characterisation, including an important question to distinguish nurses who only provide care in Health Centres from those who also provide home care. Part B includes the identification and characterisation of musculoskeletal complaints and symptoms from the past twelve months, concerning nine body regions (cervical, shoulders, elbows, wrist/hand, dorsal, lumbar, thighs, knees, and ankles/feet). Part C addresses the number of week hours dedicated to the home care and the most frequently performed activity during the provision of home care from a pre-established list. Regarding this activity, nurses had to answer a set of questions based on the technique of postural analysis (REBA) [28], thus revealing their perception of the postures (for the six body segments evaluated by REBA) they adopted during the most frequent home care activity. REBA is an observational assessment method but, in this specific case, it was only used as a basis for the questions. Part D contains questions related to various other aspects, namely some physical and psychosocial factors. The suitability of the bed height and other workplace characteristics (organisation, hygiene, and availability of patient handling aids) are examples of physical factors. The psychosocial factors are associated with work-related stress and the personality of the nurse (anxiety or irritability), as well as organisational aspects such as taking breaks during the work shift and time pressure.

The validity of parts C and D was performed using a panel of experts which explored the theoretical construct. The reliability was done by test-retest on 20 nurses, with total agreement.

## **2.2 Sample**

The questionnaire was distributed by email to the Health Centres of northern Portugal, indicating that they should be filled only by nurses. The total number of respondents was 222 in a universe of 2763 [29] (response rate of 8%). Only the complete responses (n=147) were taken into consideration in this study. About 87% of the nurses were female. The average age was 35.7 years (SD=8.88) and the average seniority in the profession was 12.8 years (SD=8.39). Approximately 85% (125) of the respondents provided home health care. The remaining 15% (22) worked exclusively in Health Centres.

## **2.3 Statistical technics**

The information from the questionnaire was statistically analysed with IBM® SPSS® Statistics version 21.0.

In order to estimate the WMSD risk in the practice of home health care, univariate models of binary logistic regression were used. In this process, “provide home care” (or not) was the factor used to evaluate the association with musculoskeletal complaints in the different body sites. Based on these results, and considering the body region most affected by home care practice, logistic regression was applied to predict the risk factors that could contribute to the onset of complaints in the nine body regions.

### 3. Results and discussion

#### 3.1 Data analysis

The body sites associated with higher prevalence of complaints were the back (cervical = 73.5%; lumbar = 64.6%; dorsal = 49.0%) and the shoulders (49.0%). These values are somewhat consistent with those of previous studies carried out in both a hospital context and a home care setting that also used questionnaires based on the Standardised Nordic Questionnaire [1,14,15].

The association between “provide home care” and “have complaints in any body region” was measured by odds ratio (OR) and respective confidence intervals (CI), using binary logistic regression models. Only the lumbar region revealed a statistically significant association (OR=3.19,  $p<0.05$ , 95% CI 1.26-8.08), as shown in Table 1. This finding means that nurses who provide home care are approximately three times more likely to have lumbar complaints than their colleagues working only in Health Centres.

Table 1 - Odds ratio and 95% CI for the different complaints.

Complaints	Odds ratio	95% CI
Cervical	1.045	[0.377, 2.897]
Dorsal	1.468	[0.585, 3.681]
<b>Lumbar</b>	<b>3.185</b>	<b>[1.256, 8.076]</b>
Thighs	0.782	[0.212, 2.883]
Knees	0.601	[0.165, 2.188]
Ankles/feet	1.412	[0.426, 4.678]
Shoulders	0.769	[0.310, 1.910]
Wrists/hands	0.972	[0.376, 2.573]
Elbows	0.611	[0.156, 2.395]

Our finding seems reasonable since nursing tasks are less physically demanding in Health Centres than in a home setting [30]. This situation is explained by the fact that nursing activities in Health Centres also include several administrative

tasks such as planning care with a clinical team, inserting data on the computer, and completing forms. According to Anderson et al. [30], nurses spend 25% of their work time in Health Centres completing tasks categorised as electronic charting or paper form completion. Nursing tasks at Health Centres also include preparing and administering vaccines and educating patients for self-care and medication administration, amongst other less physically demanding activities. Moreover, even when nurses are effectively treating patients at the Health Centre, they have more appropriate conditions, equipment, and personnel support available than in a home setting. Furthermore, patients attending Health Centres are generally more independent than patients receiving home care, as home health care in Portugal is suitable for dependent patients or patients living alone that are unable to go to Health Centres.

### **3.2 Model development**

The next step was to identify which factors related to home care were associated with "have complaints in the lumbar region". Only 56 questionnaire items were relevant to this particular objective - those associated with possible risk factors of WMSDs in a home context. The remaining items were not relevant to the objectives of this study. Therefore, the sample used only included the 125 respondents that provided home care. Although the sample size was a limitation of this work, this was attenuated by conducting a preliminary analysis of the individual effect of each variable, thus selecting the candidates for the model in a univariate process, as suggested by the literature [31].

Univariate models of binary logistic regression were applied. The dependent variable was "have complaints in the lumbar region" and 56 variables were



selected from the questionnaire as independent ones. Only eight variables were classified as “quantitative continuous” and the remaining were classified as “qualitative nominal” with two to five categories. Since there were more than two categories of independent variables (polychotomous or multinomial variables), we used a method for qualifying its attributes, through constructing artificial variables called “design variables” or “dummy variables”. This procedure consists of coding the new variables as 0 and 1, as proposed by Hosmer et al. [31]. An example of a polychotomous variable is the neck posture adopted by home care nurses during their most frequent task, which in this case has three categories ( $k=3$ ). In this situation, two dummy variables (number of dummy variables is  $k-1$ ) were needed, as illustrated in Table 2.

Table 2 - Example of application of dummy variables.

Neck posture	Code	Dummy variables	
		D <sub>1</sub>	D <sub>2</sub>
0° to 20° flexion		0	0
> 20° flexion	1	1	0
extension	2	0	1

The neck postures were compared with the reference posture, which corresponds to a neck flexion between 0° and 20°.

After the univariate analysis, only nine independent variables had a statistically significant association with the dependent variable ( $p<0.05$ ). These variables were “previous musculoskeletal disorder”, “cervical complaint”, “shoulders complaint”, “hand/wrist complaint”, “arm twist”, “work with the arm supported”, “job satisfaction”, “work stress”, and “bed height”. “Bed height” refers to an inappropriate bed height. Both "job satisfaction" and "work with the arm supported" contributed to the absence of lumbar complaints. On the other hand,

the presence of any of the other seven variables contributed to the onset of lumbar complaints.

Some variables may not influence the dependent variable at all by themselves, but do it when combined with others. The reverse may also occur [32]. Sherehiy et al. [33] found a need to investigate the combined effects of different types of WMSD risk factors because most studies only evaluated the impact of risk factors on nurses as variables acting in an independent way. Accordingly, the statistical analysis of this study continued with the application of a multivariate logistic regression, in order to develop a statistical model for home care nurses that could predict the risk of having complaints in the lumbar region.

Although only nine independent variables had a statistically significant association ( $p < 0.05$ ) with the dependent variable - and thus were considered candidates for the statistical model - the independent variables whose  $p$  was lower than 0.20 in the univariate analysis were also considered candidates, as discussed in Braga [34]. The general rule used to select variables for this analysis is  $p < 0.05$ . However, according to Bendel, Afifi, Mickey, and Greenland (cited by Hosmer et al. [31]; p. 91), this fails in some of the analysed variables. On the other hand, one should be careful when considering higher  $p$  values for the decision rule, because that may pose a risk of introducing variables with questionable interest to the model. The admission of candidate variables with  $p < 0.20$  allowed us to assess their influence on the onset of lumbar complaints when they interacted with others.

Table 3 shows the 24 variables selected for inclusion in the multivariate model.

Table 3 - Variables selected as candidates for the model.

<b>Variable</b>	<b>p</b>
Age	0.077
Seniority	0.071
Weekly workload	0.157
Accumulation	0.162
Previous musculoskeletal disorder	0.027
Cervical complaint	0.001
Dorsal complaint	0.074
Shoulders complaint	0.011
Hand/wrist complaint	0.035
Thighs complaint	0.078
Knees complaint	0.146
Ankle/feet complaint	0.080
Forearm posture	0.192
Twist/ lateral deviation of the wrists	0.075
Static postures	0.093
Repetitive movements	0.065
Twist/lateral bending of the trunk	0.055
Twist/lateral bending of the neck	0.103
Arm posture	0.101
Arm twist	0.031
Arm supported	0.009
Bed height	0.001
Stress	0.016
Job satisfaction	0.046

The construction of the model depends not only on gathering a set of variables that should be statistically evaluated but also on the intuition and knowledge of the researcher [31; p. 92,35]. Thus, variables that could contribute to lumbar complaints with  $p$  values between 0.20 and 0.25 were also analysed: “body mass index” ( $p=0.241$ ); “collaboration with colleague(s)” ( $p=0.225$ ); and “assistive devices for moving/transferring patients” ( $p=0.219$ ). These three variables are cited as potential risk factors of WMSDs by some authors [2,13,19,23].

This selection process resulted in 27 candidate variables for the statistical model. The “forward stepwise” technique coupled with the Wald statistic were used to develop the statistical model. The “forward stepwise” technique selects the strongest variables until there are no more significant predictors in the data set.

The resulting statistical model included the seven variables listed in Table 4. These variables, when acting together, contribute to the risk of home care nurses having complaints in the lumbar region.

Table 4 - Variables included in the statistical model.

Variable	B <sup>1</sup>	SE <sup>2</sup>	Wald <sup>3</sup>	df <sup>4</sup>	p-value	Exp(B) <sup>5</sup>	95% Confidence Interval for Exp(B)	
							Lower limit	Upper limit
<b>X<sub>1</sub></b>			4.479	2	0.107			
<b>X<sub>1(1)</sub></b>	-2.425	1.754	1.912	1	0.167	0.09	0.00	2.75
<b>X<sub>1(2)</sub></b>	-2.552	1.207	4.470	1	0.034	0.08	0.01	0.83
<b>X<sub>2</sub></b>	2.299	1.085	4.487	1	0.034	9.96	1.19	83.59
<b>X<sub>3</sub></b>			7.888	2	0.019			
<b>X<sub>3(1)</sub></b>	3.730	1.531	5.936	1	0.015	41.69	2.07	837.81
<b>X<sub>3(2)</sub></b>	5.857	2.094	7.824	1	0.005	349.63	5.77	21179.77
<b>X<sub>4</sub></b>	-3.161	1.114	8.044	1	0.005	0.04	0.01	0.38
<b>X<sub>5</sub></b>	1.516	0.961	2.489	1	0.115	4.56	0.69	29.91
<b>X<sub>6</sub></b>	-2.528	1.236	4.184	1	0.041	0.08	0.01	0.90
<b>X<sub>7</sub></b>	-2.867	1.946	2.170	1	0.141	0.06	0.00	2.58
<b>Const</b>	-1.306	2.006	0.424	1	0.515	0.27		

<sup>1</sup>parameter estimated for logit model; <sup>2</sup>standard error; <sup>3</sup>Wald statistic; <sup>4</sup>degrees of freedom; <sup>5</sup>estimated value of Odds Ratio.

**X<sub>1</sub>**-forearm posture; **X<sub>2</sub>**-static postures; **X<sub>3</sub>**-arm posture; **X<sub>4</sub>**-arm supported; **X<sub>5</sub>**-bed height; **X<sub>6</sub>**-job satisfaction; **X<sub>7</sub>**-assistive devices for moving/transferring patients.

The statistical model, as a logit function,  $g(x)$ , is presented in Equation 1.

$$\begin{aligned}
 g(x) = & -1.306 - 2.425 * X_{1(1)} - 2.552 * X_{1(2)} + 2.299 * X_2 \\
 & + 3.730 * X_{3(1)} + 5.857 * X_{3(2)} - 3.161 * X_4 \\
 & + 1.516 * X_5 - 2.528 * X_6 - 2.867 * X_7
 \end{aligned}
 \tag{1}$$

**X<sub>1</sub>**-forearm posture; **X<sub>2</sub>**-static postures; **X<sub>3</sub>**-arm posture; **X<sub>4</sub>**-arm supported; **X<sub>5</sub>**-bed height; **X<sub>6</sub>**-job satisfaction; **X<sub>7</sub>**-assistive devices for moving/transferring patients.

Each variable's contribution to the risk may be positive or negative depending on the sign of the estimated coefficient. The value of this estimation indicates the influence of the independent variable on the dependent variable ("have lumbar complaints"): when the coefficient estimation is positive, the variable may lead to lumbar complaints; when it is negative, the associated variable may have an opposite effect (absence of complaints).

Equation 2 allows estimating the likelihood of home care nurses having complaints in the lumbar region.

$$\hat{\pi} = \frac{e^{g(x)}}{1 + e^{g(x)}} \quad [2]$$

Different work situations can be simulated and for each one the likelihood of having lumbar complaints can be computed. We should act on the variables that form the model to obtain the lowest possible probability value, which corresponds to the absence of complaints.

Let's consider a hypothetical situation of a nurse that while performing a given task in a home care context works in the following conditions:

- forearms ( $X_{1(1)}=0, X_{1(2)}=0$ ) mainly in the reference posture (60°-100° flexion);
- static postures ( $X_2=1$ ) for more than one minute;
- arms generally ( $X_{3(1)}=1, X_{3(2)}=0$ ) between 20°-45° flexion;
- arms not supported ( $X_4=0$ );
- inadequate height of the bed ( $X_5=0$ );
- satisfaction with his/her job ( $X_6=1$ );
- no assistive devices for patient handling are available ( $X_7=1$ ).

By replacing the x values into Equation 2, we obtain the likelihood of this nurse having lumbar complaints:

$$\hat{\pi}(x) = \frac{\exp(-1.306 + 0 + 0 + 2.299 + 3.730 + 0 + 0 + 0 + 1.516 - 2.528)}{1 + \exp(-1.306 + 0 + 0 + 2.299 + 3.730 + 0 + 0 + 0 + 1.516 - 2.528)}$$

$$\hat{\pi}(x) = 0.9761$$

Under the described conditions, this nurse has a 97.61% likelihood of having complaints in the lumbar region. However, if the bed height is adjustable, its adjustment to a suitable height lowers the likelihood value to approximately 90%.

Some of the variables of our statistical model are often associated with lumbar problems in the scientific literature. For example, assistive devices are recommended by several authors for moving/transferring patients whenever possible in order to decrease the occurrence of musculoskeletal problems [2,23,36-38]. Our model indicated that a patient's bed with inadequate height could cause the nurse to acquire lumbar complaints. This finding is supported by some authors who reported that an inadequate bed height, especially a low bed height, contributes to the adoption of inadequate postures and consequently to the appearance of musculoskeletal problems [39-42]. Also, Owen and Staehler [43] found that the main sources of lumbar problems amongst home care workers were both the height and width of the patients' beds, associated with the impossibility of height adjustment.

Regarding static postures, which are often cited as a risk factor of WMSDs in the literature, our statistical model revealed that in fact sustaining static postures for more than a minute contributes to the appearance of lumbar complaints. Knibbe and Friele [15] also identified static working postures as a risk factor for back pain in nursing personnel that provided home care in the Netherlands. Moreover, in a study conducted by Cheung et al. [14] focused on home care nursing staff in Hong Kong, all the variables related to static postures were identified as WMSD risk factors.

In our statistical model, the coefficient associated with the variable "job satisfaction" has a negative value, and this is supported by several authors who state that dissatisfaction with certain working conditions may lead to musculoskeletal symptoms [44]. In a study concerning Japanese hospital nurses, Smith et al. [2] concluded that important factors such as job satisfaction, work

organisation, and occupational stress need to be taken into consideration. This should be done together with the most traditional strategies for risk reduction that emphasise manipulation tasks and other occupational factors, e.g. awkward postures, repetitive motions, and excessive effort. Another study, in which the impact of the ergonomic intervention on back pain rates was evaluated, revealed an association between pain and job dissatisfaction, and between pain and tasks involving patient handling without using mechanical aids [45].

Conversely, the study of Trinkoff et al. [46] somehow contradicts what has been stated so far. These authors found that the use of adjustable beds and transfer boards or sliding sheets was associated with higher odds of back WMSDs. Moreover, Caboor et al. [40] found that the possibility of adjusting the bed height in typical nursing tasks had significant implications for the spinal movement, although muscular activity had not changed with different bed heights. Thus, nurses may not know how to adjust the bed height properly for each type of task [40]. This finding had already been reported by de Looze et al. [42], who found that nurses have a limited ability to select the optimal bed height according to the type of task.

The remaining variables that form our statistical model are seldom mentioned, or not discussed at all, in the scientific literature regarding their possible influence on the occurrence of back problems. These variables are "posture of the arm", "posture of the forearm", and "work with the arm supported". According to the obtained statistical model and in order to minimise the complaints in the lumbar region, nurses should avoid working with their forearm in the reference posture for the forearms, which is between  $60^{\circ}$  and  $100^{\circ}$  of flexion (Figure 1a). Instead, they should use the reference posture for the arm, which is between  $20^{\circ}$  of

extension and 20° of flexion (Figure 1b). Working with a supported arm is also preferable for reducing the load generated on the lumbar spine.

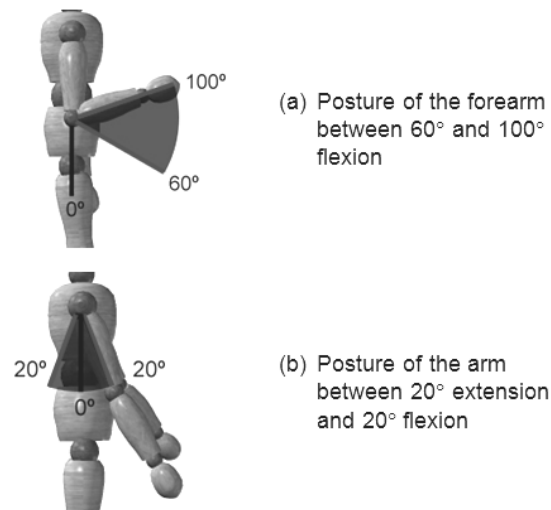


Figure 1 – Reference posture of the forearm (a) and arm (b).

### 3.3 Statistical model validation

The performance of the statistical model was evaluated by ROC analysis, which led to validation (evaluating the performance of the model on the sample used to develop the model), yielding a value of 0.884 ( $p < 0.05$ ) for the area under the ROC curve. Therefore, the statistical model can correctly predict the complaints in the lumbar region with a probability of 88.4%. The obtained ROC curve is represented in Figure 2.



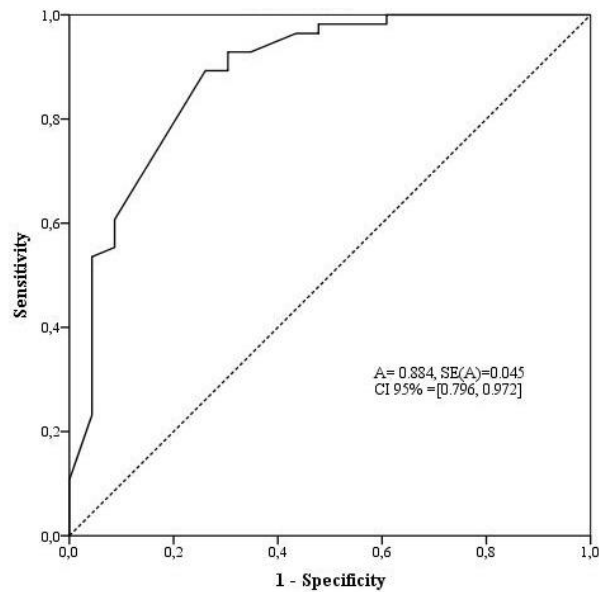


Figure 2 – Empirical ROC curve for the statistical model.

#### 4. Practical contributions

Considering the variables that form the statistical model, some recommendations for home care nurses are suggested:

- Ideally, the posture of the forearms should correspond to a flexion angle of less than 60° or greater than 100°.
- Nurses should not sustain static postures for more than a minute, but instead, strive to change their working posture frequently.
- The posture of the arms should be between 20° extension and 20° flexion, which is only possible if the nurse is quite close to the patient.
- Whenever possible, nurses should work with supported arms to reduce the load (on the arms), thereby reducing the overload on the lumbar muscles.
- Whenever possible, nurses must use assistive devices when moving/transferring patients, and encourage their acquisition if not available.

- Whenever possible, nurses should adjust the patient's bed to an adequate height, even if it is through provisional solutions (e.g. putting shims under a bed of low height).
- Since job dissatisfaction is associated with the onset of complaints in the lumbar region, it is important that nurses feel pleased with their jobs. However, job satisfaction heavily depends on organisational factors, often beyond the professional's control.

## **5. Conclusions**

The main goals of the study and the obtained results lead to some conclusions. Providing home care is a risk factor for the onset of lumbar complaints in nurses that also work in Health Centres. These professionals have about a three times higher chance of having lumbar complaints when compared to their colleagues that work only in Health Centres and do not provide home care nursing.

The statistical model obtained in this study includes seven factors that may contribute to the appearance, or absence, of lumbar complaints in home care nurses. The seven risk factors are: forearm posture, static postures, arm posture, arm supported, bed height, job satisfaction, and assistive devices for moving/transferring patients.

This statistical model can correctly predict the risk of having complaints in the lumbar region with a probability of 88.4%.

The reduced sample size is a limitation of this study, and it possibly resulted from the lack of institutional support during the distribution of the questionnaire, and the large size of the questionnaire.

In future works, it is relevant to use a larger sample size and revise and simplify the questionnaire. Increasing the sample size will also lead to the internal validation of the proposed model.

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