# Usefulness of a job-exposure matrix 'MADE' as a decision tool for compensation of work-related musculoskeletal disorders

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**Abstract**

We aimed to assess the predictivity of the biomechanical job-exposure matrix “MADE” using compensation data from the National Health Insurance for work-related disorders.

Data was obtained from 2013 to 2015, Area Under Curves (AUC), sensitivity, specificity, and predictive values were calculated using compensation results as reference.

We collected 163,128 cases data. AUC ranged from 0.64 for shoulders disorder to 0.82 for knee disorders. If two thresholds were considered, 28.7% of the sample fit under or over those.

The matrix showed a fair predictivity. Such matrix can’t replace expertise but might be a tool used for improving compensation process.

**Keywords.** public health; musculoskeletal; work; job exposure matrix; compensation; predictivity

## Introduction

Obtaining valid estimates of occupational exposure is an important issue in many epidemiological studies dealing with such questions. The direct measurement of exposure through observation of workers is an accurate method but is limited to a short period of observation, and is very expensive and time-consuming. [1] Self-reported questionnaires are easier to administer for large populations, but exposures are often less accurate, and responses may be subject to recall bias and altered perception of exposures in some cases.[2]

In this context, job exposure matrices (JEMs) have been proposed for chemical exposures and some physical exposure.[2,3] These matrices give a correspondence between job titles (generally defined by the combination of a profession and an activity sector) and probability, intensity and/or frequency of one or more exposure. Recently, JEM for biomechanical exposures has also been developed in Denmark, and France.[4–5]

Interestingly, JEM has been also suggested not only for research purpose, but also for public health.[6] In France, tools based on JEM have been developed to help occupational health practitioners assess global exposure, which may lead to early retirement.[7] Compensation of musculoskeletal disorder as an occupational disease requires exposure assessment. JEM might be used to optimize the first evaluation.

We aimed to study the predictivity of a biomechanical job-exposure matrix compared to musculoskeletal data of National compensation health insurance for work-related disorders and injuries.

## Methods

*French compensation system*

The French system for recognition of the occupational nature of a disease is based on two possibilities:[8]

A list system (called in French Tables): If the disease is listed as an occupational disease and if the "related conditions" (i.e. diagnosis criteria, time condition -diagnostic delay, sometime duration of exposure -type of exposure) are met, the disease is presumed to be occupational and the disease is compensated. For musculoskeletal disorder, there is a high recognition rate due to broad "related condition".

A complementary system: If the conditions are not met or if the disease does not appear in the list, compensation is possible if (1) victim has a predictable permanent disability rate over 25%; and (2) a committee determine that the disease is directly (and essentially if there is no existing list) related to work exposure.

*Study*

Blind compensation data of work-related musculoskeletal disorders in France were obtained from 2013 to 2015. We included the following disorders that are compensated: acute shoulder tendonitis (acute, chronic with or without rupture), elbow nerve entrapment, epicondylitis (bursitis not included), hand/wrist nerve entrapments, hand/wrist tendonitis, meniscus disorders, and chronic low back pain with sciatica. Job title is coded using the 2008 International Standard Classification of Occupations (ISCO).

The main outcome was the compensation results, i.e. acceptance or rejection. We only included rejection for lack of exposure. Other rejections for medical discrepancies, time from end of exposure or medical diagnosis were not included, as well as missing data for job title.

A job-exposure matrix called “MADE” (*for “difficult physical conditions and job matrix”* in French) was developed for research purposes, based on the 2008 ISCO for 17 biomechanical exposures coded from 0 to 5 by expert assessment who weren’t involved in the compensation process.[5] (Appendix 1) The most relevant exposure variables were used for each locations considered: rating of exertion and shoulder postures for shoulder tendonitis, static strength for ulnar nerve entrapment at the elbow, elbow postures for epicondylitis, hand grip for hand/wrist nerve entrapments and tendonitis, kneeling or squatting for meniscus disorders and carrying heavy loads (i.e. >25kg) for chronic low back pain with sciatica.

Dataset was randomly divided into two subsamples in order to check the stability of the statistical results (main and validation subsample, respectively two third and one third of all sample). Disorders have been studied separately according to the exposure considered in the list/table system. Area Under Curves (AUC) of Receiver Operative Characteristic curves, as well as sensitivity, specificity, predictive values were calculated in each subsample using the compensation results as reference. The proportion of accepted and rejected cases was calculated based on the JEM using two thresholds that were estimated to have approximatively 0.90 sensitivity and specificity (appendix 2). The other subsample helped check the validity of the results.



*Ethics*

We worked on blind compensation data which required no ethic committee or consent.

## Results

In three years, 163,128 cases were available, with a high proportion of acceptance (94%), 110,000 in the main subgroup and 53,128 in the validation subgroup. In the main subgroup, for shoulder disorders, $AUC_{effort}$ and $AUC_{shoulders\ postures}$ were respectively 0.67[0.66;0.68] and 0.64[0.62;0.65]; for ulnar nerve entrapment at the elbow, $AUC_{static\ strength}$ was 0.71[0.68;0.74]; for epicondylitis, $AUC_{elbow\ posture}$ was 0.75[0.73;0.76]; for hand/wrist nerve entrapments and tendonitis, $AUC_{hand\ grip}$ was 0.73[0.72;0.74]; for meniscus disorders, $AUC_{kneeling\text{-}squatting}$ was 0.82[0.79;0.84]; for chronic low back pain with sciatica carrying, $AUC_{carrying\ very\ heavy\ loads}$ was 0.75[0.76;0.76].

The threshold optimized for sensitivity and specificity was over 0.90 in most cases, but none reached both 0.90 sensitivity and specificity for the same threshold (Table). If two thresholds are considered, 28.7% of the sample fit under or over those (examples in supplementary data 2). Results were very similar in the other subsample.



## Discussion

Compared to the data of National compensation health insurance of work-related musculoskeletal disorders and injuries, the biomechanical job-exposure matrix “MADE” showed a fair predictivity, though two thresholds must be used for the matrix to be used as a decision tool for compensation.

Some limitations should be discussed. Firstly, for non-specialists, coding the described job is complicated.[6] Though computerized approaches have been studied, they aren’t implemented yet.[9] However, misclassification would lead to underestimating the accuracy because we used existing data, and the decision of compensation is made using the complete description of the job and not the coding job. Secondly, there are ongoing discussions about the homogeneity of response throughout France, with possible difference of compensation rate between some areas, which is likely caused by the variability of the expert's opinion.[10] However, because of the large number of cases, the weight of those variations has probably low incidence on the results. Similarly, the high acceptance rates might artificially increase predictive values. Nevertheless, in addition that these are what are expected in our country, results on sensitivity and specificity made us confident on similar results in another situation with a lower acceptance rate. Finally, a JEM reflects an average level of exposure of the factor considered for a job, and cannot summarize all the individual professional situations.[6] The aim here is clearly to have a decision tool, and not to replace expertise.

This work is a unique way to transpose knowledge from research to Public health. A first attempt was using asbestos JEMs for compensation purpose in the ESPACES project and was continued in the framework of the ESPRIT and SPIRALE programs, extended to other carcinogens including wood dust.[6] The fact that the JEM provides a valid predictive answer in more than a quarter of situations will help clarify and document complex situations (and might be optimized later). This will also help harmonizing practices of experts in France.

In conclusion, a decision tool based on a biomechanical JEM like "MADE" is useful. Every country can use their own JEM for Public health practice such as compensation. Improving compensation process is important for prevention.

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**Conflict of interest**.

No conflict of interest declared.
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**Key points:**

- The biomechanical job-exposure matrix "MADE" showed a fair predictivity.
- Two thresholds must be used for the matrix to be used as a decision tool for compensation.
- Job-exposure matrix may help improving compensation process.

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Table: Predictivity of the biomechanical job-exposure matrix "MADE" versus decision of compensation for work-related musculoskeletal disorders for the two randomized subsamples (regular font main subsample, and *italic* font for validation subsample with same threshold "idem")

| | Number of cases | Thresholds (scales from 0 to 5) | Sensitivity | Specificity | Positive predictive value | Negative predictive value |
|---|---|---|---|---|---|---|
| **Shoulder, upper threshold** | **28027** | Exertion >3 | 22.9% | 94.5% | 97.7% | 10.9% |
| ***Shoulder, upper threshold*** | ***13593*** | *Idem* | *22.9%* | *94.0%* | *97.4%* | *10.9%* |
| **Shoulder lower threshold** | **28027** | Shoulder posture <0.6 | 96.1% | 17.3% | 92.1% | 30.5% |
| ***Shoulder, lower threshold*** | ***13593*** | *idem* | *95.9%* | *17.7%* | *92.1%* | *30.3%* |
| **UNEE, upper threshold** | **3126** | Static strength >2.6 | 27.8% | 90.8% | 95.9% | 14.0% |
| ***UNEE, upper threshold*** | ***1477*** | *idem* | *29.6%* | *90.1%* | *95.5%* | *15.2%* |
| **UNEE, lower threshold** | **3126** | Static strength <1.05 | 94.7% | 22.4% | 90.4% | 35.1% |
| ***UNEE, lower threshold*** | ***1477*** | *Idem* | *95.7%* | *23.8%* | *90.0%* | *43.4%* |
| **Epicondylitis, upper threshold** | **22202** | Elbow postures >2.6 | 34.2% | 91.3% | 99.1% | 4.5% |
| ***Epicondylitis, upper threshold*** | ***10715*** | *Idem* | *34.2%* | *86.5%* | *98.7%* | *4.0%* |
| **Epicondylitis, lower threshold** | **22202** | Elbow postures <0.8 | 95.4% | 31.6% | 97.6% | 19.0% |
| ***Epicondylitis, lower threshold*** | ***10715*** | *Idem* | *95.2%* | *35.7%* | *97.9%* | *19.3%* |
| **Hand, upper threshold** | **48428** | Hand grip >2.6 | 27.9% | 96.0% | 99.4% | 5.6% |
| ***Hand, upper threshold*** | ***23424*** | *Idem* | *28.0%* | *95.9%* | *99.4%* | *5.4%* |
| **Hand, lower threshold** | **48428** | Hand grip <0.3 | 92.0% | 38.4% | 97.1% | 17.5% |
| ***Hand, lower threshold*** | ***23424*** | *Idem* | *91.8%* | *37.8%* | *97.2%* | *16.4%* |
| **Meniscus, upper threshold** | **1545** | Kneeling/squatting >2.3 | 57.6% | 91.4% | 97.3% | 28.9% |
| ***Meniscus, upper threshold*** | ***742*** | *Idem* | *56.3%* | *90.7%* | *97.0%* | *28.2%* |
| **Meniscus, lower threshold** | **1545** | Kneeling/squatting <1.0 | 93.2% | 40.0% | 89.2% | 52.7% |
| ***Meniscus, lower threshold*** | ***742*** | *Idem* | *94.4%* | *30.5%* | *87.8%* | *50.7%* |
| **Sciatica, upper threshold** | **6268** | Carrying heavy loads (i.e. >25kg)> 2.3 | 37.2% | 91.1% | 96.6% | 17.5% |
| ***Sciatica, upper threshold*** | ***2982*** | *Idem* | *35.7%* | *90.3%* | *96.5%* | *15.7%* |
| **Sciatica, lower threshold** | **6268** | Carrying heavy loads (i.e. >25kg) <0.75 | 94.0% | 22.3% | 89.2% | 35.2% |
| ***Sciatica, lower threshold*** | ***2982*** | *Idem* | *35.7%* | *90.3%* | *96.5%* | *15.7%* |

UNEE Ulnar nerve entrapment at elbow