Assessment of postural stress among bricklayers in a construction company

Bouhafs Mebarkia, Mohammed Argoubb,c, Cheikh el Bachir Tebboune

Abstract: The aim of the present study is to highlight one of the main causes of musculoskeletal disorders (MSDs) in construction industry in Algeria, through the identification and evaluation of working postures adopted by bricklayers during wall construction tasks, using standardized questionnaire Nordic type (Kuorinka, I et al, 1987) for the analysis of MSDs, and the OWAS method of investigation and analysis of work postures (Karhu et al, 1977), on a sample of 32 subjects. The results of the study revealed that over 90% of bricklayers suffer from discomfort, and stiffness or pain in the lower back, and over 81% at the shoulders level. Evaluation of 48 working postures showed that poor postures were adopted during 56.24 % of the working time, which need an ergonomic intervention in the medium and long term, as they were classified in category 2 and 3 of the OWAS method. The rest of the observed postures belonged to category 1. However, no posture was classified in category 4 (high biomechanical stress posture requiring urgent intervention). Although, OWAS method did not reveal any high biomechanical stress posture, screening of MSDs by the questionnaire technique showed the presence of such disorders among workers, which can be explained by the presence of a combination of three triggering factors (a) adoption of strenuous postures for long periods of time in the absence of regular rest pauses (b) the weights handled while carrying out tasks of wall building (c) the high pace of work imposed by the organization rules.

Practitioner Summary: This study showed the importance of postural constraints among bricklayers. Poor working methods, layout and organization of the workplace and materials were at the roots of inadequate working postures. Practical recommendations are put forward to address the shortcomings of the design of tasks, postures and work techniques.

Keywords: work postures, musculoskeletal disorders, OWAS method, building tasks, bricklayers.

1. Introduction

Awkward and strenuous working postures and movements in building and construction sector are widespread (Schneider, 2001; CSST, 2014). These are well known to be associated with musculoskeletal disorders (MSDs) (Schneider, 2001), while the most stressful tasks for cement workers in building and construction sites are brick-laying tasks, as has been observed by LI, K, W et al. (1999), postures adopted while carrying out such tasks are a major triggering cause of MSDs, especially in the back and the lumbar region. ILO statistics show that MSDs constitute ¾ of occupational diseases in the construction industry and represents a huge expense (ILO, 1997). While the European Agency for Safety and Health at Work report show that MSDs constitutes 59 % of occupational diseases in EU member states (EASHW, 2010). We might then, deduce that statistical figures can be higher in less developed countries, due to poor working conditions, the International Labour Organization reports are alarming in this respect (ILO, 2013).

According to official figures, the declared workforce in the building and construction sector in Algeria counts for 19.9% of the total active workforce in 2013 (ONS, 2013). But these figures should be taken with some reserve, they might be much more higher, as undeclared workforce (informal employment) is a widespread practice in this sector of activity, according to the Algerian office of statistics (ONS, 2012, p. 11). Survey 3.9 million Algerians out of 9.7 million of the employed population are working in the informal, 37.4 % of them are in the building and construction industry.

Although poor and unsafe work conditions are widespread in the Algerian construction industry, which employ a large segment of the work force, both in formal and in informal employment, published scientific material on the subject is scarce. The objective of the present study is to assess postural stress among bricklaying workers in a construction site using two ergonomics tools as described below.

2. Method and Procedures
To identify and evaluate the working postures adopted by bricklayers during wall construction, two techniques were used (1) a standardized questionnaire Nordic type (Kuorinka et al, 1987) for analysis of MSDs, and (2) the method of investigation and analysis OWAS (Karhu et al, 1977).

2.1 The sample

The age of the workers involved in the study was 40.97 (8.15) years, while their working experience was 07.57 (37.5) years and 14.31 (8.11) years, within and outside the company, respectively. Their body weight and stature were 87.68 (8.01) kg, and 170.81 (6.94) millimeter, respectively. All the bricklayers in the construction site were male workers (n=32) took part in the administration of the questionnaire. Four (4) of them, assigned arbitrary, were video recorded during different stages of wall construction while performing building tasks. Ordinary scale was used to weigh subject’s body weight, working tools and materials. Subject’s stature and wall height were measured using ordinary steel tape.

2.2 Observation and interviews

In order to gather information on working methods and techniques, working postures adopted while performing the different tasks, and to elaborate a list of all tasks and stages of wall construction, structured interviews were conducted with the workers (members of the sample), supervisors, occupational health and safety practitioner of the company.

2.3 The questionnaire

To screening the presence of musculoskeletal disorders among bricklaying workers of the sample, a standardized questionnaire Nordic type (Kuorinka et al., 1987) was used, as “screening of the musculoskeletal disorders may serve as a diagnostic tool for analyzing the work environment, workstations and tool design” (Kuorinka et al., 1987, 2). Both general and specific questions of the original questionnaire were translated into Arabic and adapted to the real activities, working tools and postural situations of bricklaying tasks.

Administration of the questionnaire, with the assistance of a member of the research team, was performed at the end of the working shift and lasted twelve (12) days, with an average of three (3) questionnaires /day.

2.4 OWAS method

The OWAS method was used to identify and evaluate working postures adopted by bricklayers during wall construction tasks. The OWAS method has proved to be reliably and easily used to analyse work postures in different work situation, particularly in construction sites (Li and Lee, 1999, Kivi and Mattila, 1991, Mattila et al., 1993).

The direct observation of the work postures was realised with a video recording camera during the construction period of a wall (Length=3.20m - Height=2.90m). Four (4) workers assigned arbitrary were video recorded during different stages of wall construction while performing building tasks.

A total recording time of twelve (12) hours and 50 minutes was transferred into a laptop, and played back with a freeze frame every 15 sec. so that the working postures of the back, upper limbs, lower limbs, and weight handled could be sampled and coded.

3. Results

3.1 Diagnostic of musculoskeletal disorders

The results of screening of musculoskeletal disorders among bricklaying workers of the sample revealed the presence of Pain and stiffness in the back, shoulders and hands, besides the symptoms of allergy, headaches and stomachaches, both, before and after joining the company.

Table 1. Shows the type of complaints before and after joining the company.

<table>
<thead>
<tr>
<th>Type of complaints</th>
<th>Before joining the company</th>
<th>After joining the company</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

Table 1. Shows the type of complaints before and after joining the company.
Pain/stiffness
In the back 13  25
Pain/stiffness
At the shoulders 02  09
Pain/stiffness
In hands 04  10
Allergy/bowel pain/headaches 05  10

The administration of the questionnaire at the end of the working shift revealed the presence of discomfort, stiffness and pain in some areas of the body both, during the last 12 months and the last seven (7) days in bricklaying workers of the sample (n=32), as shown in table 2.

Table 2. Shows the percentage (%) of discomfort, stiffness and pain in parts of the body.

<table>
<thead>
<tr>
<th>body area</th>
<th>% of discomfort / stiffness / pain during last 12 months</th>
<th>% of discomfort / stiffness / pain during last 7 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck</td>
<td>25.00</td>
<td>06.25</td>
</tr>
<tr>
<td>Shoulders</td>
<td><strong>81.25</strong></td>
<td><strong>68.25</strong></td>
</tr>
<tr>
<td>Knees / thighs</td>
<td>50.00</td>
<td>37.50</td>
</tr>
<tr>
<td>Elbows / forearms</td>
<td>09.37</td>
<td>06.25</td>
</tr>
<tr>
<td>Hands / wrists</td>
<td>18.75</td>
<td>25.00</td>
</tr>
<tr>
<td>Fingers</td>
<td>28.12</td>
<td>21.87</td>
</tr>
<tr>
<td>Upper back</td>
<td><strong>68.75</strong></td>
<td><strong>62.50</strong></td>
</tr>
<tr>
<td>Lower back</td>
<td><strong>90.62</strong></td>
<td><strong>87.50</strong></td>
</tr>
<tr>
<td>Pelvis and hip / buttock</td>
<td>56.25</td>
<td>37.50</td>
</tr>
<tr>
<td>Feet</td>
<td>43.75</td>
<td>37.50</td>
</tr>
</tbody>
</table>

3.2 Assessment of Postures

The outcome of the posture sampling operation was 3078 observations, which comprised forty eight (48) postures. The analysis of the forty eight (48) postures revealed the following results as shown in table 3:

(1) The leaning forward posture was predominantly the most adopted posture during wall construction work, with an adoption frequency of 94.13%.

(2) The classification of the forty eight (48) postures with OWAS method was as follows:
- Category 1: twenty one (21) postures were classified in the 1st category, with a total frequency of 1628 times, corresponding to 52.89% of the working time.
- Category 2: sixteen (16) postures were classified in the 2nd category, with a total frequency of 1399 times, corresponding to 45.45% of the working time.
- Category 3: eleven (11) postures were classified in the 3rd category, with a total frequency of 51 times, corresponding to 1.65% of the working time.
- Category 4: No posture was classified into Category 4.

Table 3. Shows the frequency of different postures classified by category * for a sample of 4 workers carrying out wall construction tasks.

<table>
<thead>
<tr>
<th>Posture Category *</th>
<th>(n)</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 1</td>
<td>21</td>
<td>1628</td>
<td>52.89</td>
</tr>
<tr>
<td>Category 2</td>
<td>16</td>
<td>1399</td>
<td>45.45</td>
</tr>
<tr>
<td>Category 3</td>
<td>11</td>
<td>51</td>
<td>1.65</td>
</tr>
<tr>
<td>Category 4</td>
<td>00</td>
<td>00</td>
<td>00</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>3078</td>
<td>100</td>
</tr>
</tbody>
</table>
The results of weight handled during wall construction time, revealed that the weight of ≤ 10 kg was handled for 98.79% of the time, mostly while adopting postures of the category one and two of the OWAS method as shown in table 4.

Table 4. The frequency of postures classified by category* and weight handled in each postural category for a sample of 4 workers during wall construction time.

<table>
<thead>
<tr>
<th>Weight handled</th>
<th>≤ 10 kg</th>
<th>10 – 20 kg</th>
<th>≥ 20 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 1</td>
<td>1593</td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td>Category 2</td>
<td>1397</td>
<td>02</td>
<td>00</td>
</tr>
<tr>
<td>Category 3</td>
<td>46</td>
<td>00</td>
<td>05</td>
</tr>
<tr>
<td>Category 4</td>
<td>00</td>
<td>00</td>
<td>00</td>
</tr>
<tr>
<td>Total</td>
<td>3036</td>
<td>16</td>
<td>26</td>
</tr>
<tr>
<td>%</td>
<td>98.79%</td>
<td>0.52%</td>
<td>0.85%</td>
</tr>
</tbody>
</table>

* For details on posture category classification refer to Kerhu et al. (1977) and Kerhu et al. (1981).

4. Discussion

The results of the present study have revealed the presence of musculoskeletal disorders among bricklaying workers of the sample, which manifested through symptoms of Pain and stiffness in the back, shoulders and hands, both before and after joining the company (table1). These are common symptoms in cement workers as has been shown in many studies (Li, et al., 1999, Schneider, 2001).

The presence of discomfort, stiffness and pain in upper and lower limbs, shoulders and back, was common among bricklaying workers, both during the last 12 months and last the seven (7) days. But as can be noticed from the results (table2), these symptoms were predominantly high in three particular areas: (a) the lower back region with 90.62% and 87.50% (b) the shoulders region with 81.25% and 68.25%, and (c) the upper back region with 68.75% and 62.50%, during the last 12 months and the last 7 days, respectively.

These results were confirmed by the postural assessment figures (table3) emerged from the application of OWAS method, where the leaning forward posture was predominantly the most adopted posture during 94.13% of working time while performing wall construction tasks. The leaning forward in a standing position was adopted during 90.62% of the working time. The combination of standing, leaning forward and trunk twisting posture was adopted during 81.25% of the working time.

Although these postures were distributed between category one and category two of OWAS method (postures that require no immediate corrective action), they still were strenuous, as they were adopted for long periods of time, besides their combination with repetitive movements and load handling (≤ 10 kg for 98.79% of the working time). The combination of such postures, weight handling tasks, and heavy physical workload are known to be directly associated with work related MSDs (Ismail et al., 2009).

Manual handling of constructing materials in bricklaying tasks were mainly of the sort of: positioning and adjusting bricks between pillars (or parallel bars), hammering, manual handling of bricks, mortar, brick-laying, mortar finishing, manual handling of scaffold frames and planks assembling and disassembling. These tasks are known to engage repetitive motion of the hand and wrist, fingers manipulation, etc., which in turn are a source of discomfort, stiffness and pain in these parts of the body as has been shown in this study (table 2). These complaints are widely reported in the literature (Li and Lee, 1999, Lee, 1998). But as justly has been advanced by Li and Lee (1999, p.6), the repetitive motion of the wrist and hand cannot be recorded by OWAS method due to its work sampling nature and the absence of wrist postures classification in basic OWAS. Their proposition to incorporate hand postures into OWAS method seems reasonable. The use of the questionnaire for the analysis MSDs, as a supplementary method in the present study was justified as its results compensated the shortcomings of OWAS.
The presence of MSDs among bricklaying workers of the present study can be explained by the presence of three triggering factors: the adoption of strenuous postures, the weights handled while carrying out tasks of wall building and the pace of work imposed by the rules of the company.

To remediate to the situation, action can be undertaken at two complimentary levels:

(a) at a micro ergonomics level: To avoid/reduce body bending and repetitive movement of the back, ergonomics intervention may focus on the redesign of work stations by creating adjustable work surfaces which can be moved up and down to maintain the proper working height, and can easily be moved horizontally to avoid exerting muscular force in pushing, pulling or lifting work materials and equipment (buckets of mortar and bricks). The adjustable work station for bricklaying tasks should reduce to a maximum body twisting, by placing bricks and buckets of mortar right in front of the workers, instead of by the side, as has been recommended by Li and Lee, 1999, Kivi and Mattila, 1991, Schneider and Susi, 1994. However, bending forward and squatting/kneeling postures, while working on low wall, particularly the first few rows of bricks, was a problematic, a partial solution might be in reducing the time span between rest poses, and wearing knee braces to support the worker’s knees while adopting kneeling postures.

(b) At a macro ergonomics level: work methods and work pacing are to be thoroughly studied. Work procedures, too, have to be reviewed. In the absence of appropriate work methods, of skilled workers and of clear work procedures, many unnecessary repetitive movements are performed, and awkward postures are adopted, particularly when the company imposes a high pace of work for untrained workers.

5. Conclusion

This study presented an ergonomic assessment of postural stress as a main cause of musculoskeletal disorders (MSDs) in construction industry in Algeria. Using a standardized questionnaire Nordic type and the method of investigation and analysis OWAS, the results of the study revealed the presence of discomfort, stiffness and pain in different areas of the body in bricklaying workers, the frequency of these symptoms was particularly high in the lower back and at shoulders’ level. Evaluation of working postures in bricklaying workers showed that strenuous postures were adopted during a large proportion of the working time.

Although the results of the present study were in line with previous research work, they should be valorized by the implementation of two main recommendations concerning (a) the redesign of work stations, the review of work methods and work pacing, and (b) further clarification of work procedures. Which means, in practical terms, a reduction of postural stress among bricklayers in building and construction sector.

References


