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Musculoskeletal Problems among Brick Packers: A Nigeria Perspective

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Abstract
A field survey examined the problems caused by manual sorting and packing of bricks. 139 packers from 12 plans completed the Nordic Musculoskeletal questionnaire. Heart rates were recorded over a shift for 45 workers, and their postures were videoed. Rates of musculoskeletal trouble were found to be very high, particularly in the wrists/hands and low back and were higher in completely manual system (‘hand packing) than in semi-mechanized systems (‘monorails). Hand packing produced higher heart rates and required more bending and twisting. Where the task cannot be mechanized action should be taken on reduce the risks.
Keywords: musculoskeletal problem, brick packers, sorting, posture, risk.

1 Introduction

Bricks are fired in kilns at temperatures of about 1200^0C in stacks with spaces for hot gases to circulate. After firing and cooling they are transferred, outside the kiln, to dispatch packs which are tightly packed. As they are packed bricks are inspected for defects such as excessive colour variations and cracks. Normal defect rates range from over 10% to under 1%. Where problems in firing occur reject rates can be very high.

In automated packing manual handling has been eliminated except for removal of seconds and rejects or in the event of mechanical breakdown. In some manual packing system mechanized jigs (‘monorais’) are used for building dispatch packs. The jigs are indexed between packing workstations at fixed intervals and each worker is expected to place a set number of bricks into each jig before it moves on. In hand packing bricks are plucked from a fixed kiln pack to a fixed dispatch pack. Usually in a fixed jig. Hand packers are typically given a set number of bricks to pack and work at their own pace.

Standard bricks are 100mm x 65 mm x 210mm and range in weight from about 1.8kg to more than 3.0kg. Inspection policies may require a packer to handle only two bricks at once (one per hand) or may permit handling five or more bricks at once (usually held between the hands). ‘Maximum Brick Limits’ (MBLs) may also be used to attempt to control the risks of manual handling. Loads handled can be in the region of 12.5-13 kg. Total loads may exceed 30 tonnes per man per day. Kiln packs are typically up to 1.5m high and four brick lengths deep. Jigs are typically 8 bricks high. Monorail Jigs are two brick lengths deep, but hand packing jigs are usually five brick lengths deep.

The Nigeria Ceramics Confederation (NCC) (1998) estimated that 650 workers were employed by member firms in hand sorting/ packing. In 1996-7 13 sites using monorails reported 21 three-day accident under RIDDOR 95 and 17 sites using hand packing reported 16 accidents. The mean numbers of bricks per worker per shift were 14178 on monorails and 14167 for hand-packing. The annual injury rates per million daily bricks ranged from 0 to 16.7 (mean 4.31, SD 5.73) on monorails and from 0 to 28.9 (mean 3.71, SD 6.81) on hand packing. These rates are not significantly different and suggest that in unfavorable circumstances severe problems can arise in both systems.

Ferreira and Tracy (1991) compared work practices in two plants with monorails with different injury rates and suggested that difference in work organization and methods of handling could be influencing the injury rates. They described workers in the pant with more injuries as having handling techniques and work organization which were characterized by lack of variety, whereas the other plant was characterized by versatility, and used a wide variety, whereas the other plant was characterized by versatility, and used a wide variety of handling techniques.

The NCC (1998) described two questions as unresolved:1) The relative risks of hand packing and packing on monorails; and 2). The relative risks of handling 5 bricks at a time and of handling 2 bricks at a time ad therefore lifting 2.5 times as often. Therefore a field investigation was undertaken to address these issues.

2. Methods

The study was approved by the HSE Research Ethics Committee. The survey aspect of the study was granted ministerial approval under the Survey Control procedures for government departments which wish to undertake statistical survey's in industry. All subjects gave informed consent before participating.

The aim had been to study six sites using monorails and six using hand packing, three of each with MBLs of 4/5, and three of each with MBLs OF 2, in a factorial design. It was found included. Examining MBLs solely within hand packing was also impossible as only two plants with MBLs of 2 could be identified. A plant with an MBL of 3 was found, but this limit was ignored by the packers who handled up to 7 bricks once.

HSE has used the Nordic Musculoskeletal Questionnaire to survey the prevalence of musculoskeletal 'trouble' ('ache, pain, discomfort or numbness) across a number of work forces (Dickinson et al., 1992, Dickinson, 1998). Questions are asked for each of nine body regions to establish the annual prevalence, the weekly prevalence and the annual disability. All available packers were asked to complete the NMQ, normally during a morning break.

Heart rates were measured over a normal shift for up to four workers at each plant using Polar Heart Rate Monitors (Polar Electro Oy, Finland). Resting heart rate was the minimum in part of a rest break with a standard deviation of less than 5 beats per minute. Working heart rate was the mean heart rate over a one hour period that did not include a break. Heart rate reserve was the difference between maximum (220-age, a strand and working and resting heart rates.

Video recording of the activities of the packers whose heart rates were being measured were made over the shift. Tapes from four plants were coded at 1 minute intervals using the observer Pro video analysis system (Noldus information technology BV, The Netherlands) to control the video tape. The WinOWAS software was used to asses the postures. This relates time-sampled postures to 'Action Categories' linked to recommendations of the urgency of remedial action (Karhu *et al*, 1977, Vedder, 1998). It assigns Action Categories (table 1) from the percentage of time that a body part is in a particular posture.

4. Results

4.1 Survey of musculoskeletal trouble

Excluding unavailable workers, the overall response rate for the NMQ was 82%. Basic anthropometric and personal data are reported in table 2. The only statistically significant difference ($P<0.05$) between the two groups of packers was that the hand packers had on average almost three years more experience.

Annual and weekly prevalence of musculoskeletal trouble are given in Table 3 for hand and monorail packers, and for data collected by HSE from bricklayers and the 1985 Nordic Reference Data set (Foundation for Occupational and Environmental Medical Research and Development, Orebro, 1985), Table 3 also gives the suggestions of Dickinson (1998), for 'high' action levels for annual prevalence's.

The levels of trouble reported were very much higher than both the Nordic data and the 'high' levels of Dickinson (1998). The highest rates were in the wrists/hands and the lower back. Three significant differences were found between the two packing methods with hand packing worse in each case. The annual prevalences in the lower back were 87% respectively ($x^2 =4.33$, $p<0.05$). The weekly prevalence in the wrists/hands was nearly twice that of monorail packers (48% and 26%, $x^2 =7.22$, $p<0.01$) and more than twice that in the upper back (32% and 15%, $x^2 =5.29$, $p<0.05$).

While bricklayers also have high prevalences, the problems are different and less severe than in packers. Their weekly prevalence was 13% in the wrists/hands, but 48% and 26% for hand and monorail packers respectively. In the lower back the frequencies were 26% for bricklayers and 64% for hand and monorail packers.

4.2 Heart rates in hand packing and monorail packing

A significant difference of 8.8 bpm ($p<0.05$) was found in the working heart rates of the two types of

packing but one was not found for resting heart rate (Table 4). As a result, significant differences existed in heart rate reserve ($p<0.05$) and work pulse ($p<0.05$).

4.3 Posture analysis

The posture analysis shows (Table 5) that at most 13% of the time was spent postures in AC3 and AC 4. For the two monorails approximately two-thirds of the postures were AC 1. However, for the hand packing sites, under 50% of the postures were AC 1, and over 50% were AC 2. Therefore, in terms of gross postures, hand packing is worse than monorail packing. Bending and twisting of the trunk reached AC 3 in three plants and AC 2 in the other and twisting by itself also reached AC 2 in one plant. It is therefore necessary to reduce the amount of bending and/or twisting, which will be best achieved by redesign of packing workstations and kiln and dispatch packs. Reducing bending would best be done by increasing minimum heights of lift.

5. Discussion

This study indicates that manual sorting and packing of bricks is a high risk activity for musculoskeletal disorders. The very high levels of musculoskeletal trouble found among packers, particularly in the wrists/hands and the lower back, are far in excess of mean levels in working populations in Nigeria and other African countries and are very high when compared to bricklaying. The heart rate data revealed that packing falls into the broad categories, as defined for men aged 20-30 (Astrand and Rodahl, 1986), of moderate work' on monorails and 'heavy work' in hand packing. Therefore hand packing is worse than monorail packing, as it has more reported musculoskeletal problems, is more strenuous, and involves more bending and stooping. Therefore it can be seen that the method of packing adopted has an effect on the musculoskeletal hazards of a job requiring large amounts of manual handling.

The current trend within the industry is to mechanize packing and this is clearly the most effectives method of reducing the risks from this task. However, manual sorting and packing will need to continue in some circumstances, particularly where waste rates are high or where production volumes are low. A proactive approach to management of the associated risks to musculoskeletal heath will therefore be essential.

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Table 1 OWAS Action Categories

Action category	**Meaning**	**Action required**
AC1	Normal posture	No action required
AC2	Slightly harmful posture	Action required in the near future
AC 3	Distinctly harmful posture	Action required as soon as possible
AC 4	Extremely harmful posture	Action required immediately

Table 2. Anthropometric and work duration data

	All packers (n=139) Mean (SD)	Hand packing (n=67) Mean (SD)	Monorail packing (N=72) Mean (SD)
Age (years)	36.9 (8.9(	37.5 (9.3)	36.4 (8.5)
Weight (kg)	77.9 (10.4)	77.4 (9.4)	78.4 (11.1)
Height (m)	1.77 (0.07)	1.78 (0.06)	1.77 (0.07)
BMI (kg/m^2)	24.8 (2.9)	24.5 (2.9)	25.1 (2.9)
Experience (years)	8.7 (8.3)	10.2 (9.8)	7.3 (6.2)

Table 3. Annual/weekly prevalence data

	Hand packing N=67)	Monorail (n=72)	Bricklayers (n=127)	Nordic Reference (n=7569)	Dickinson (1998)
Neck	34%/14%	39%/13%	32%/8%	24%/11%	30%
Shoulders	49%/17%	48%/25%	36%/6%	24%/11%	26%
Elbows	46%/26%	33%/17%	32%/9%	10%/4%	9%
Wrists/hands	78%/48%	63%/26%	49%/13%	13%/6%	25%
Upper back	39%/32%	25%/15%	14%/5%	10%/4%	12%
Lower back	87%/64%	72%/47%	61%/26%	41%/15%	44%
Hips/thighs/ buttocks	46%/29%	43%/29%	13%/5%	11%/5%	12%
Knees	33%/14%	31%/13%	28%/6%	25%/10%	27%
Ankles/feet	19%/11%	21%/13%	17%/4%	13%/6%	14%

Table 4. Heart rate data (bpm) from monorails and hand packing

	Hand packing (n=22) mean (SD)	Monorails (n=23) Mean (SD)	t value (unpaired t-test)
Working heart rate	115.3 (13.7)	106.5 (9.6)	2.45
Resting heart rate	78.3 (7.6)	75.3 (8.1)	1.25
Heart rate reserve	102.8 (9.7)	111.3 (11.7)	2.60
Work pulse	37.0 (9.5)	31.2 (7.3)	2.25

Table 5. Percentage of postures assigned to the different OWAS Action Categories at the different plants.

	Packing method	No of observations	AC 1	AC 2	AC 3	AC 4
Plant A	Monorail	1,215	69%	18%	4%	9%
Plant B	Hand packing	250	44%	54%	2%	1%
Plant C	Hand packing	1,193	40%	56%	1%	2%
Plant D	Monorail	745	61%	37%	0%	1%