Pattern of accidents in an iron factory in the Eastern Province of Saudi Arabia

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Abstract
Objectives: To determine the pattern, types and causes of occupational accidents and identify the at risk groups in an iron forging factory.

Design: Retrospective search of the company's accident report and the General Organization for Social Insurance's notification form retained by the hospital contracted.

Setting: Steel Buildings Company, Dammam, Eastern Province.

Subjects: The administrative staff and laborers in the company during 1989 (total 547) and 1990 (total 628). Excluded were those permanently stationed elsewhere.

Results: A total of 104 and 114 incidents were recorded with 851 and 1107 lost man-days, in 1989 and 1990, respectively. Saudis, who were younger (p<0.0001), had significantly higher relative risk of accidents. Both incident and frequency rates were high for the laborers. The commonest types of injuries in both years were wounds followed by sprains. Fall of or hit by objects were the prime causes, and hands and fingers were the body parts most frequently injured. Negative human behavior was a major contributory factor.

Conclusions: The pattern of accidents was remarkably similar between the two years. Young, inexperienced employees were at greater risk. A training program in safe work practice has much to commend it. It is recommended that a center be established to collate and analyze data with the objective of preventing work related disorders.

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Keywords: Saudi Arabia, occupational accidents, social insurance.

The rapid expansion in industry in the Kingdom of Saudi Arabia (KSA) during the last decade has, as expected, increased the possibility of work-related disorders namely, diseases and accidents, which are undesirable events.

In the absence of accident prevention programs or effective leadership in accident prevention they can be a serious threat to the welfare of the individual and his family. Indeed, accidents can very much jeopardize industrial development.

Accident analysis in the KSA is confined to hospital reports. In one series of 135 wrist injuries, 33% of them were of occupational origin. In another report the majority of 40 cases of vascular injuries were due to industrial causes.

It has been estimated that more than five million on-the-job injuries occurred throughout the USA during the year 1986.

Knowledge of accident rates, types and causes are the key to formulating preventive programs. This study aims at identifying the types and causes of job related accidents and the groups at risk in an iron forging factory (Steel Buildings Company, Dammam), in the Eastern Province of the KSA during a two year period (1989 and 1990).

Methods All the accidents that occurred within the premises of the factory (including the Administration) during the two years were recorded. The data were later verified from the employees' medical records at the hospital contracted with and from the accident report (General Organization for Social Insurance, GOSI, Form 10). The following relevant information was obtained and recorded by the investigator from the Company's personnel and the accidents' reports:

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demographic variables, months of experience, place, cause and date of accident, anatomical site, type of injury, days off sick, host factors (such as negligence, lack of training, etc.), and the factory section. These were: Administration (Admin) (unexposed group), pre-engineered building (PEB), structural steel plant (SSP), contracts and erection (CE), and towers and galvanizing (TG). Employees in these last four sections form the exposed group. The population at risk was the mid-year population in each of the two years. Employees permanently stationed at other sites were excluded.

The total working days and man-hours worked per year were computed after subtracting all days lost through vacations and injury. Access to personnel files to calculate the days lost through absences other than accidents was not possible. Consequently, the total man hours worked per year may be an overestimate and the computed frequency rate (disabling accidents/10^6 man hours worked) and severity rate (days lost/10^2 man hours worked) may thus be an underestimate if such absenteeism did occur.

The different accident rates were calculated as follows:

Frequency rate = \( \frac{\text{Total number of disabling accidents} \times 10^6}{\text{Total man-hours worked}} \)

Incident rate = \( \frac{\text{Total number of accidents} \times 10^3}{\text{average number of persons exposed}} \)

Severity rate = \( \frac{\text{Total days lost} \times 1000}{\text{Total man-hours worked}} \)

A disabling accident is one which caused absence from work.

These two years were selected because the records were relatively complete. Furthermore, comparison between two years would give a better insight into the problem.

A data base file was created in EPI INFO version 5.01 on an IBM compatible personal computer. Statistical analysis was carried out using this program and SPSS PC (statistical package). The statistical methods used included one way analysis of variance and chi-squared tests. The relative risk (RR) with the 95% confidence interval (95% CI) was also calculated where appropriate. A p-value of 0.05 or less was taken as the statistical level of significance.

Results

The total employees, all males, were 547 in 1989 and 628 in 1990 (Table 1). Saudis constituted 6.9% and 6.2% in 1989 and 1990 respectively. The company has no formal training program in occupational health and safety.

There were 104 and 114 incidents during 1989 and 1990, respectively, with only three among the Admin staff (2 in 1989). Those who experienced more than one accident were 16.0% in 1989 and 14.9% in 1990. Saudi nationals, who were significantly younger and less experienced, had the highest rates in both years (44.7% and 41.0%, p < 0.00001 for 1989 and < 0.00004 for 1990) (RR: 95% CI of 2.62 : 1.75 -3.91, and 2.47 : 1.62 - 3.74, respectively). Those from the Indian subcontinent also had significant RR during 1989 but this was not as high as for the Saudis (Table 1). Job type was not a significant factor in the cause of accident.

<p>| Table 1: Accidents frequency and relative risk (RR, 95% confidence intervals) by year and nationality. |
| --- | --- | --- | --- |</p>
<table>
<thead>
<tr>
<th>Nationality</th>
<th>With accidents</th>
<th>RR &amp; (95% C.I.)</th>
<th>With accidents &amp; RR (95% C.I.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saudis</td>
<td>17 (17.1)</td>
<td>2.62 (1.75-3.31)</td>
<td>16 (16.0)</td>
</tr>
<tr>
<td>Filipinos</td>
<td>35 (27.6)</td>
<td>0.49 (0.34-0.71)</td>
<td>56 (34.1)</td>
</tr>
<tr>
<td>Indian-subcontinent</td>
<td>46 (14.4)</td>
<td>1.70 (1.21-2.39)</td>
<td>40 (12.9)</td>
</tr>
<tr>
<td>Other Arabs</td>
<td>6 (15.0)</td>
<td>0.78 (0.36-1.66)</td>
<td>24 (5.0)</td>
</tr>
<tr>
<td>Europeans &amp; Americans</td>
<td>0 (0.0)</td>
<td>0.00 (0.00-1.00)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Total</td>
<td>104 (19.0)</td>
<td>1.14 (0.72-1.82)</td>
<td>114 (18.2)</td>
</tr>
</tbody>
</table>

According to an official company report the total accidents during this year were 119. The records of these accidents were missing from the company’s register.

The reference for each nationality is the collective rate for the other nationalities.

Days lost were not recorded for 5 incidents in 1989 and 10 in 1990. Six accidents in 1989 and eight in 1990 did not cause loss of time. The resulting man-days lost during the two years were 851 (range 0-229) and 1107 (range 0-231). The average days lost per incident per year during 1989 was 8.2 and 9.7 for 1990 and 16.8 days per person year for the whole company.

During 1989 the Filipinos were, on average, the oldest and had the longest duration of service (p < 0.0001, and p < 0.000001, respectively, (Table 2). The Duncan statistic showed the Saudis were younger than the Filipinos and those from the
burns of the neck, arm and shoulders (first patient), and all body parts, except the back of the second. Multiple injuries were 3.8% and 4.8% in 1989 and 1990, respectively.

Approximately 48.0% of the injuries during 1989 and 50.0% of those during 1990 were in the 33-42 year age group. The rates of wounds in the 25-44 years group were 78.9% and 73.5% in 1989 and 1990, respectively. Very few of the injured were aged 53 or more (1.0% in 1989 and 1.8% in 1990).

The most frequent causes of accidents in 1989 were hit by or fall of objects and foreign bodies. Each type accounted for more than a fifth (22 incidents) of the 103 accidents for which the causes were known, followed by handling of materials or operating machines (15, 14.6%). Hand tools caused 11 (10.7%) accidents and metal fragments a further 10 (9.7%). The remaining 45 accidents were due to other factors such as part of the body being caught between machine or material, crane, fork lift or attachments, flying foreign bodies (metallic and dust), underwater causes, chemicals, hot liquids, flame and falls from heights. Similarly, for 1990 falls of or hit by heavy objects were responsible for 31 (27.7%) of the 112 known causes. The second commonest cause was flying foreign bodies (26, 23.2%). The remaining 55 were due to the rest of the causes mentioned under 1989.

During 1989 the hand or fingers alone were the parts most frequently injured (46, 44.2%), while the remaining parts of the upper limb collectively were involved in only 2 (1.9%) incidents. The corresponding figures for the 112 accidents with anatomical sites recorded during 1990 were 33 (29.5%) and 6 (5.4%). The feet were involved in nearly 8.0% of the incidents in 1989 compared to 14.0% in the following year. The rest of the lower limb was involved in 9.6% (10 incidents) and 8.0% (9 incidents) in 1989 and 1990, respectively.

Eye injuries amounted to 22.1% of all accidents in 1989 and 27.7% in 1990. Welding, loading/unloading trucks and cleaning of metals by pneumatic chisels were the activities mostly associated with eye injuries in both years (83.3% in 1989 and 71.8% in 1990 of all causes). Back pain was reported only twice in 1990 causing a loss of 31 days.

Although the accidents were more frequent in the PEB section during both years (59 and 45) than in TG (24 and 30), yet the man days lost were more in the latter section (371 and 388 for PEB compared with 388 and 398 for TG). The equivalent lost days from SSP were 90 and 190 and the rest were from CE and Admin. The 46
hand and finger injuries in 1989 caused a loss of 602 man days, and the 33 incidents in 1990 caused a loss of 322 man days. While no toes were injured in 1989, 4 such incidents the following year were responsible for a loss of 363 man days (Table 3).

Negligence, unsafe acts or carelessness were the predominant negative human behavior in all age groups contributing to accidents during both years (63.5% for 1989 and 68.4% for 1990). "Accidental" reasons were behind 17.3% and 15.8% of the incidents in the two years. In 1989 overconfidence, other's faults and lack of training collectively contributed by 8.6% to the accidents. Only over-confidence was recorded during 1990. No reasons were stated for 11 (10.6%) and 17 (14.9%) of the incidents during 1989 and 1990, respectively. The highest rates of negligence, unsafe acts and carelessness during both years were in the 33-42 year age group (28.8% in 1989 and 34.2% in 1990) followed by the 23-32 age group. Older age groups had less rates.

Table 3: Lost man-days by anatomical site for the years 1989 and 1990.

<table>
<thead>
<tr>
<th>Body part</th>
<th>Total days lost (%)</th>
<th>1989</th>
<th>1990</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eyes</td>
<td>23 (2.7)</td>
<td>34 (3.1)</td>
<td></td>
</tr>
<tr>
<td>Hand/fingers</td>
<td>602 (70.7)</td>
<td>322 (3.1)</td>
<td></td>
</tr>
<tr>
<td>Other parts of upper limb</td>
<td>2 (0.2)</td>
<td>38 (3.4)</td>
<td></td>
</tr>
<tr>
<td>Head/face</td>
<td>20 (2.4)</td>
<td>25 (2.3)</td>
<td></td>
</tr>
<tr>
<td>Trunk</td>
<td>23 (2.7)</td>
<td>47 (4.3)</td>
<td></td>
</tr>
<tr>
<td>Foot/ankle</td>
<td>128 (15.0)</td>
<td>124 (11.3)</td>
<td></td>
</tr>
<tr>
<td>Toes</td>
<td>-</td>
<td>363 (32.9)</td>
<td></td>
</tr>
<tr>
<td>Knees</td>
<td>18 (2.1)</td>
<td>16 (1.5)</td>
<td></td>
</tr>
<tr>
<td>Thigh/leg</td>
<td>21 (2.5)</td>
<td>5 (0.4)</td>
<td></td>
</tr>
<tr>
<td>More than one body part</td>
<td>14 (1.6)</td>
<td>128 (11.6)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>851</td>
<td>1102*</td>
<td></td>
</tr>
</tbody>
</table>

* For five days lost the anatomical site was not recorded.

Discussion Analysis of industrial accidents is important for deciding priorities and identifying the high risk groups and areas in the factory where attention is needed most. All work related disorders among the insured in the KSA are, by law, reported to GOSI for treatment and, if need be, assessment of the degree of residual disability with the appropriate financial compensation. However, accident analysis does not come under its domain.

Work in this factory involves extensive manual handling of materials and the use of fork lifts and overhead cranes. Hand tools, such as electric grinding discs, pneumatic chisels and cutting and pressing machines, are used to produce the final product. The manufacturing industry has always been a high risk sector for accidents particularly the metal products division. This results in high lost time claim rates. The high rate of wounds during both years among the 25-44 years, the most active age group, was much higher than that in a previous study where two thirds of the wounds involved this age group. The injured were on average younger and less experienced, had the highest rates of accidents. Of 102 serious accidents reported from Finland, 66.7% were in the age group 25-50 years. As observed in this study, lower rates have also been reported for older employees. The latter authors attributed this low rate to the acquisition of experience with age and the healthy worker effect (survivor population) by virtue of their safe job practices. However, the young and inexperienced workers are more likely to be employed in hazardous jobs since senior colleagues often choose less hazardous work sites.

The majority of the incidents resulted in wounds particularly in the PEB, SSP and TG sections where material handling was extensive. This result was thus not unexpected particularly since there was an absence of close work performance monitoring.

The calculated man-days lost might be an underestimate for two reasons. First, the days lost for 15 incidents were unknown and secondly, the unavailability of dates on days lost through absences other than occupational injuries. Consequently, the denominator (actual man-hours worked) will be inflated when computing frequency and severity rates. Hence, these two rates may not reflect the true situation.

The most frequent cause of accidents in the present and other studies was hit by or fall of heavy objects. Lack of attention on the part of the employees and bad housekeeping might greatly contribute to this.

Excess welding material is removed by grinding machines and pneumatic chisels. It is therefore not surprising that foreign bodies lodging in different parts of the body, particularly the eyes, rank third. Pneumatic chisels can set metal fragments and dust particles flying in air for long distances which calls for their replacement by safer methods.

Hands and fingers were the commonest anatomical sites to be affected in both years causing long days of absence. This finding is in agreement with previous reports.
Negative human behavior in the present study was an important contributory factor in the majority of incidents. Carelessness and unsafe acts by the injured have been reported to be among the significant factors in the cause of accidents.\cite{6,7} It is a fact that accident causation is multifactoral. These include, among others, faulty judgment, taking risks (short cuts), distraction, unfamiliarity with the job,\cite{4} and unsafe work practice. These with organizational factors should be taken into consideration when formulating prevention programs.\cite{4,10} A well trained employee is expected to be safety minded and will not be careless or take risks. Consequently, all human behavior labeled by supervisors in this study as carelessness, negligence, unsafe acts or over confidence, can be a by-product of lack of training.

It was not possible to calculate the exact financial and productivity loss incurred by this company but this was not expected to be low. However, any such attempts would have underestimated the true cost of work injuries since the cost of suffering and pain are not always considered in such estimations.\cite{11}

It is imperative that a thorough description of the antecedents (whether temporary or permanent) be included in any attempt to develop an intervention program\cite{12} to combat this high rate of accidents. Isolated (as per need) programs directed toward changing employees' behavior and/or work practices might not be effective enough since such programs are unlikely to consider the organizational and environmental factors which cause accidents.

There is a need for "an integrative work place health program" such as that described by De Joy and Southern\cite{13} which essentially consists of three phases: ensuring support of the factory management, problem identification (work environment, job done and work characteristics or extra organizational factors), and designing and implementing the program with evaluation of the progress.

The accident rate was found to be more in the less experienced. In order to avoid unnecessary morbidity and work related disorders, a pre-employment selection examination may help identify the applicants who are at a relatively higher risk\cite{14} and who would require off and on the job training as well as instructions on occupational health and safety.

**Conclusion** This study has shown that the pattern of accidents in the two years in this company is remarkably similar in terms of accident rates, injury type, body part injured, section with the highest rates, groups at risk and the factors contributing to injury. This was largely because of the absence of safety training and intervention programs.

It is recommended that a center be established in the KSA to collate and analyze data with the object of preventing work-related disorders. There are such centers in other countries and they are known for their efficiency.\cite{15} Since GOSI is the legal authority to which all occupational disorders are notified, it is suggested that this center be part of GOSI in each province in the Kingdom. This will enable active surveillance of all work-related disorders to be conducted and the introduction of appropriately timed intervention programs. The expected outcome should be a reduction in morbidity, mortality, medical costs of treatment and rehabilitation and an increase in productivity.\cite{16}

**Acknowledgment** The author would like to thank the Director General, GOSI, Eastern Province and the Company's Administration for their permission to conduct this study and to Al Mana's General Hospital for their help with photocopying GOSI form 10. Special thanks are due to Professor E. Larbi for his constructive criticism and to Mr. Ismail Ibrahim, the company's public relations officer and Mr. Edgar Aquino, Personnel Department, for their most valuable assistance in making the necessary records available. Thanks are also due to Ms Tita Florentino who patiently typed this text.

**References**


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ملخص

الهدف: دراسة تطبيق وتحديد الأنواع والأساليب الرئيسية لإصابات المهنية، وكذلك معرفة المجموعات الأكثر عرضة للمخاطر في مصنع للصناعات الحديدية.

طريقة البحث: تم جمع المعلومات من مسجلات الشركة، وكذلك استمارة رقم 10 الخاصة بتبليغ الإصابات إلى المؤسسة العامة للتأمينات الاجتماعية والحفاظ على المستشفيات المعالج والمتعاون معها بواسطة الشركة.

المكان: شركة المباني الحديدية بالدمام - المنطقة الشرقية.

مجموعة الدراسة: كل الإداريين والعمال خلال السنوات 1990 و1991م. تم تحليل الدراسة العماليين بصورة دائمة في فروع الشركة خارج منطقة الدراسة كان مجموعهم من شملتهم الدراسة 67 في العام الأول و68 في العام الثاني.

نتائج: كان عدد الإصابات المهنية 104 في سنة 1990 و114 في السنة التالية أدت إلى ضياع ما مجموعه 851 يوم عمل في السنة الأولى و1107 يوم في السنة الثانية. السعوديون أصغر عمرًا وأقل خبرة من البقية واحتمال الإصابة بينهم خلال السنين كان عالياً وهو دلالة إحصائية مؤكدة. نسبة الوفوع والحدوث التكرار كانتا مرتفعتين بين العاملين داخل المصنع. الجروح هي أكثر أنواع الإصابات تأتي بعدها في الترتيب للإصابات. سقوط المواد أو الارتفاع بها كانت هي الأسباب الرائدة، بينما الإصابات الأضرار هي أجزاء الجسم الأكثر إصابة.

إن التصرفات الخاطئة من قبل العاملين من أهم العوامل التي ساعدت على الإصابة.

الخلاصة والتوصيات: خلصت هذه الدراسة إلى أن طرق الإصابات متشابه إلى حد كبير بين السنين وأن العاملين الأقل خبرة في حاجة إلى تدريب على أسس السلامة والصحة المهنية. ويوصي بتدريب العاملين على هذا وكذلك إنشاء مركز جمع وتحليل الأمراض والإصابات المهنية بهدف اتخاذ الوسائط المناسبة لمنعها.

الكلمات الرئيسية: المملكة العربية السعودية، الإصابات المهنية، التأمينات الاجتماعية.