# ASSESSMENT OF CUT AND PUNCTURE WOUNDS IN METAL FABRICATION INDUSTRY

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**Abstract:** Metal Fabrication (MetFab) is the process of building machines and structures from raw metal materials. The process of MetFab includes cutting, burning, welding, machining, forming, and assembly to heavy equipment and machinery and comes with numerous hazards such as cut and puncture injuries (CP-injuries). The aim of this study was to conduct an assessment of MetFab-related injuries among metal fabricators. The objectives intended to find the leading causes of workers' exposure to CP-injuries and compare work methods adopted by the workers with the recommended guidelines. Data was collected with the aid of a structured questionnaire among 250 metal fabricators. The data was analyzed using SPSS. The outcome of the study revealed that **a**bout 78.0% of the metal fabricators suffered from abrasion injuries, 88.0% suffered cut injuries while 38% reported laceration. Hands region was mostly affected by 94% of the subjects. According to 58% of the total respondents, the injuries resulted into loss of dexterity while 56% had loss of grip; improper selection of tools for the job was among the major leading causal factors. The study revealed that ergonomic recommended guidelines relevant to MetFab industry were not followed. The subjects' workstations were hazardous. It was recommended that metal fabricators should be trained on proper selection of right tools and PPE. The application of ergonomic guidelines should been forced among the workers to enhance occupational health and safety of the workers.

**Keywords:** Cut, puncture, hazards, ergonomic, metal, fabrication

## Introduction

Metal fabrication is the creation of metal structures by cutting, bending and assembling processes. It is a value-added process involving the creation of machines, parts, and structures from various raw materials (Aaron, 2016). Specific subsectors include cutlery and hand tools; architectural and structural metals; hardware manufacturing; spring and wire manufacturing; screw; nut; bolt manufacturing; and forging and stamping (Koll and Mangrove, 2017). Metal fabrication can be hazardous and injurious. The most common injuries develop over time. These injuries among others include: eye injuries, repetitive strain injuries, burns, machine entanglement injuries, reaction injuries and hearing loss injuries (Ambrose *et al*., 2016).

The biggest dangers in working with sheet metal are the potential for cuts and punctures. Lammers and Smith (2014) define a cut as a break or opening in the skin. It is also called a laceration. A cut may be deep, smooth, or jagged. It may be near the surface of the skin or deeper. A deep cut can affect tendons, muscles, ligaments, nerves, blood vessels or bone. A puncture is a wound made by a pointed object such as a nail, knife, or sharp tooth. The symptoms include: bleeding, problems with function or feeling below the wound site, pain, and so forth (Simon and Hern, 2018).

Safety is an important issue in MetFab because of the complexity of the production process. A safe working MetFab environment can reduce cut and puncture injuries (Heinrich, 2011). Safety equipment usable in MetFab includes the gadgets that are used for the protection of life and to avoid injuries or casualties. MacDonald (2017) emphasized the use of Personal Protective Equipment (PPE), such as, gloves, foot wears, protective coat, garment, helmet, welding glasses or goggles, mouth and nose masks, air-purifying respirator, in a MetFab industry. According to Bob (2018), PPE are ideal for ensuring that metal fabricators stay protected, against cuts and puncture, breathing in sheet metal dust, skin burns, bright flashes, chemicals and sharp edge punctures, metal fumes and ultraviolet radiation when fabricating metal.

One important PPE in MetFab is hand gloves. There are reported types of gloves available for industrial use. These are grouped into ; lightweight gloves which may offer some protection against contaminants like dirt or dust, disposable gloves, chemical and liquid resistant gloves, puncture and cut resistant gloves, thermal proof gloves, impact and vibration resistant gloves and heavy-duty gloves.

According to Mack (2016), occupational health and hazard is not a new issue in the MetFab industry. Thousands of workers all around the world fall prey to mismanaged systems and health negligence on a daily basis. There are thousands of metal fabricators who have been injured at work even sadly deaths becoming quite common (Lammers and Smith, 2014). According to Simon and Hern (2018), metal fabricators are constantly under the exposure of unreliable tools, machinery, and unsafe working conditions which often leads to mishaps.

Adopting ergonomic guidelines in work method is a way to reduce injuries (Adeyemi *et al*., 2017) in MetFab workstations. Coker *et al*. (2013) defined ergonomics as the science of refining the design of products to optimize them for human use. Burgess-Limerick (2014) defined ergonomics as the study of a workplace and the equipment designed for comfort, efficiency, safety, and productivity. Flood and Decker (2016) concludes that an ergonomically metal fabrication industry helps to avoid fatigue, injuries, discomfort, and provide a safe work environment for the fabricators.

This study is geared toward assessing the work methods and the prevalence of cut and puncture injuries in metal fabrication industry. The objectives of this study are to study the causal factors for cut and puncture wounds and suggest ergonomics measures that will reduce the prevalence.

## Materials and Methods

### *Study area*

The research study was conducted in seven (07) Local Government Areas (LGAs) (Ikeja, Ifako-Ijaye, Lagos Island, Surulere, Apapa, Eti-Osa and Ikorodu) of Lagos State. Lagos State houses about eighty percent (80%) of the industries in Nigeria. Lagos State, as shown in Fig. 1, is bounded in the North and in the West by Ogun State, respectively, and in the East and South by Atlantic Ocean, respectively (Ander, 2018). Lagos State covers an immense area, with a total of 1,171.28 square kilometers (452.23 square miles). The population continues to grow, and currently exceeding 17.5 million residents, the population density is around 6,871 residents per square kilometer (17,800 per square mile) (National Population Commission, 2019; Ander, 2018; National Bureau of Statistics, 2018; United Nations, 2018).


**Fig. 1: The map of Lagos State (Ander, 2018)**

***Sampling technique and data collection***

***Type and source of data***

Data for the study was obtained mainly through the primary information source. The primary data was collected with the aid of a structured questionnaire which was administered to metal fabricators.

The population was drawn from some MetFab Industries and some metal fabricating

staff in the industries. The population was purposefully selected from all the existing MetFab Industries in Lagos State.

***Sampling technique and sample size***

Ten (10) MetFab Industries, accommodating all types of fabrication were randomly and purposefully selected for the study. The sample size consisted of one hundred (100) metal fabricators from ten (10) MetFab Industries who were randomly selected.

***Data analysis***

The data was cleaned, validated and analyzed using SPSS (for windows, version 22.0) for processing and analyzing. Quantitative variables were summarized using percentages, mean and standard deviation. Categorical variables were tabulated using frequencies and percentages.

**Results and Discussion**

***Reported injuries suffered previously or on current job***

Figure 2 indicates that a majority (78.0%) of the metal fabricators suffered from abrasion, while 46.0% of the respondents suffered injuries from sharp injuries. 38.0, 36.0, 34.0 and 24.0% out of the metal fabricators had suffered from lacerations, contact wounds, incision and stab wounds respectively. This is not unconnected with friction, scrape, rub or wear off, attrition, disintegration that are associated with cutting, welding, stamping, forging, punching and so on in metal fabrication.

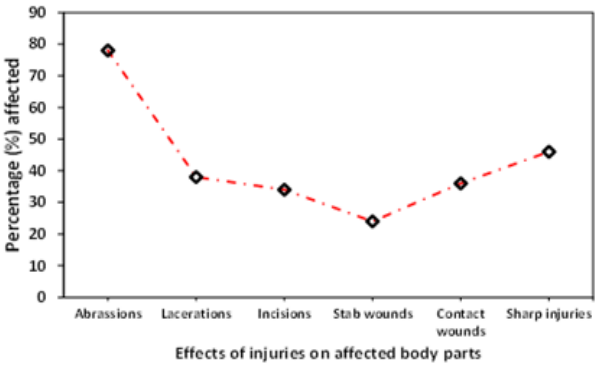


**Fig. 2: Reported Injuries suffered on the job**

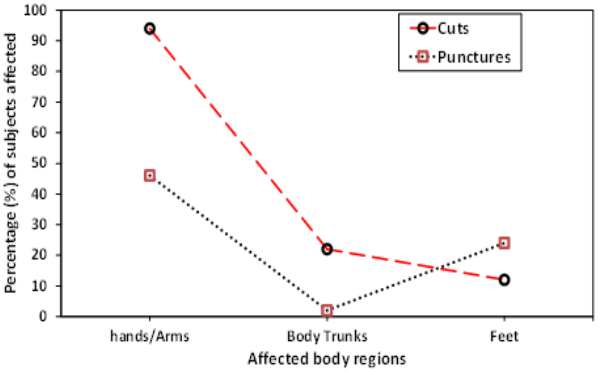


**Fig. 3: Reported Body regions affected by cut and puncture injuries**

***Reported Effects of cut and puncture injuries***

Figure 3 shows that 94.0% of the respondents had cut injuries on the hands or arms, while 22.0% out of the subjects had cuts wounds on the body trunk. About 12.0% had cut injuries on the feet. After a severe hand injury, the hand may not function as it did previously, due to loss of motion, dexterity and grip. In some cases, workers may not be able to perform simple tasks. Many hand hazards are equipment-related which may include vibrating equipment, rotating equipment and equipment pinch points. Cuts or lacerations may affect nerves, tendons or muscles. Bone fractures can damage nearby tissue and may be difficult to repair.

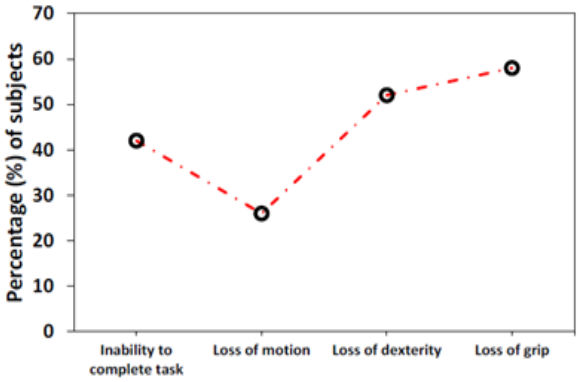


**Fig. 4: Reported health impacts of cut and puncture injuries on body regions**

Figure 4 shows that 52.0% had loss of dexterity and 58% experienced loss of grip, while 26.0 and 42.0% had loss of motion and loss the ability to complete simplest tasks, respectively. Fig. 3.6 shows that cut wounds occurred more frequently with 88.0% while puncture wounds occurred less frequently with 12.0%. The findings revealed that metal fabricators experienced more of cut injuries.

Table 1 shows the mean, responses of the subjects on 5-point Likert scale. Responses on the use of hand tools and work methods rated between 1 and 2.4 were considered compliant with ergonomic guidelines that may reduce injury occurrence. Scores that fall between 2.5 and 5.0 were rated poor work habits and/or work method that may promote work related injuries among the subjects.

The results indicated that majority of the metal fabricators were involved in wrong handling of tools and use wrong methods. These wrong handling of tools include the use of; any type of driver size for any screw work, screwdrivers with chipped tips, any types of hammer for all kinds of jobs, any type of chisel for all kinds of jobs and chisels as pry bars. About 56, 48, 58, 49 and 53% of the subjects were affected, respectively. Among the wrong work methods discovered include; working on machinery without guards in place and holding parts of work piece with hands while working.

**Table 1: Assessed Work habits and work methods among MetFab workers**

| Schedule | Work habits and work method assessed | Mean ($\bar{x}$) respond | SD ($\sigma^2$) | Percentages of subjects (%) |
|---|---|---|---|---|
| A | **Use of Hand Tools** | | | |
| | Screwdrivers as chisels or pry bars | 2.320* | 1.0906 | 66 |
| | Any type of driver size for any screw work | 3.900* | 1.0871 | 56 |
| | Use of screwdrivers with chipped tips | 3.120† | 0.9978 | 48 |
| | Use of hammer with cracked or loose handle | 2.500* | 0.9898 | 67 |
| | Using any types of hammer for all kinds of jobs | 3.700† | 1.4249 | 58 |
| | Using any type of chisel for all kinds of jobs | 3.600† | 1.1192 | 49 |
| | Using chisels as pry bars | 3.100† | 1.2910 | 53 |
| B. | **Handling Machinery** | | | |
| | Change of tool blades without unplugging or locking out | 2.080* | 1.0980 | 71 |
| | Work on machinery without guards in place | 3.180* | 1.1493 | 61 |
| | Hold parts of work piece with hands while working | 3.100* | 1.0916 | 46 |
| C. | **Job Understanding** | | | |
| | Need more training to understand the hazards and dangers in the job | 3.840* | 1.0320 | 61 |
| | Not fully aware of pinch points of the job | 2.400* | 1.0050 | 57 |

*Disagree (Mean $\bar{x}$< 3), Agree (Mean $\bar{x}$> 3).

**Table 2: Types of gloves used by the subjects compared with the recommended gloves**

| Measured activities | Reported (%) | | | | | | | | Recommended Types of gloves | Subjects that complied with the recommended (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| | None | Type 1 | Type 2 | Type 3 | Type 4 | Type 5 | Type 6 | Type 7 | | |
| Working with Extreme high temperature | 5 | | | | 43 | 35 | | 22 | Type 5 | 35 |
| Handling sheet metal | 42 | 16 | | | 15 | | | | Type 4 | 15 |
| Carrying out heavy cutting | 25 | 23 | | | 3 | | | 12 | Type 4, Type 7 | 15 |
| Welding works | 38 | | | | | 35 | | | Type 5 | 35 |
| Equipment handling | 18 | | | | 25 | 21 | | | Type 4, Type 5 | 46 |
| Light duty material handling | 56 | 3 | | | | | | | Type 1 | 56 |
| Clean-up works | 58 | | 12 | 14 | | | | | Type 2, Type 3 | 26 |

Type 1= Lightweight gloves, Type 2 = Disposable gloves, Type 3 = Chemical and liquid resistant gloves, Type 4 = Tear, puncture, and cut resistant gloves, Type 5 =Thermal proof gloves, Type 6 = Impact and vibration resistant gloves Type 7 = Heavy-duty gloves

Among all the six (6) activities measured as stated in Table 2, about two (2) representing 33.3% compliant with the types of gloves recommended for such activity. Only 35% of the subjects used the correct type of glove when working with Extreme high temperature, 15% used the correct glove handling sheet metal and in the process of carrying out heavy cutting, more than 65% used wrong gloves during welding works and only 26% used the right glove for cleanup tasks. However, in light duty material and equipment handlings 56% and 46% of the subjects used the correct gloves.

To minimize cut and puncture injuries, ergonomic measures including proper selection of right tools, training and retraining of workers, the use of proper PPE including pairs of cut-puncture-resistance gloves is necessary. There is also an urgent need for legislative control on manufacturers' activities as well as the environment where metal fabrications are carried out their tasks.

## Conclusion

This study assessed the various defects in the work methods of metal fabrication industries. The study showed a high prevalence of cut and puncture injuries among workers making the industry a significant health concern workplace. Common causative factors of cut and puncture wounds identified included use of wrong tools and self-confidence of workers in handling tools. Others were poor guarding, use of

wrong types of gloves and lack of proper understanding of safety regulations. Prevalently, almost all the subjects had sustained cut or puncture injuries, and majority had suffered from abrasion. The application of ergonomic standards in MetFab industries will ensures good health, comfort, and well-being of employees.

**Conflict of Interest**

Authors declare there is no conflict of interest related to this study.

**References**


Aaron C 2016. What is metal fabrication and where is the industry headed? *Am. J. Technical Stud.*, 7(2): 67 – 79.

Adeyemi HO, Martins OO, Adejuyigbe SB & Adekunle AA 2017. Rate of ergonomics hazard control measures incorporation into small-scale industries in Southwest Nigeria. *Safety Engineering*, 7(1): 21-28.

Ambrose D, Wild P and & Moulin JJ 2016. Frequent metal injuries in metal fabrication shop: Update of a meta-analysis on lung cancer and fabrication. *Scand J. Work Environ Health*, 32(1): 22 – 31.

Ander B 2018. The political structure of Lagos State, Nigeria. *Wilimedia Commons*, 34 – 45.

Bob W 2018. Hazards of MetFab. *Am. J. Med. Assoc.*, 12(18): 45 – 55.

Burgess-Limerick R 2014. Participatory ergonomics: Evidence and implementation lessons. *J. Human Factors and Ergonomics Soc.*, 56(7): 858 – 872.

Coker P, James MA & Gomez GR 2013. Voluntary Ergonomics guideline for the sheet metal fabrication industry. *Am. Metal Fabricators Assoc. (AMFA) Publ.*, 45(23): 345 – 460.

Dempsey P 2014. Applied ergonomics: Human factors in technology and society. *J. Ergonomic Engr.*, 45(19): 456 – 460.

Flood L & Decker P 2016. An Ergonomic Approach: Engineering Report. Birmingham: Bettcher Industries Co.

Heinrich H 2001). Industrial Accident Prevention. New York: McGraw-Hill.

Koll KJ & Mangrove PM 2017. Concentration of sheet metal fabrication, cost and effect. *J. Bus. Econ.*, 23(5): 89 – 96.

Lammers RL & Smith ZE 2014. Principles of wound management. In: Roberts JR, Hedges JR, eds. *Roberts and Hedges' Clinical Procedures in Emergency Medicine*. (5th ed.), Philadelphia: P. A. Elsevier Saunders.

MacDonald DO 2017. Safety equipment in fabrication construction. *J. Engr. and Sci.*, 5(12): 2 – 6.

Mack H 2016. Occupational health and hazard. *Int. J. Med. Sci.*, 6(10): 34 – 40.

National Bureau of Statistics 2018. Nigeria data and statistics. *Bulletin*, 45(9): 32 – 36.

National Population Commission 2019. Lagos State population data. *Bulletin*, 46(12): 3 – 15.

Simon BC & Hern HG 2018. Wound management principles. In: Walls RM, Hockberger RS, Gausche-Hill M eds, *Rosen's Emergency Medicine: Concepts and Clinical Practice.* (9th ed.). Philadelphia: P. A Elsevier Saunders.

Smith PE 2018. Sheet metal fabrication: Techniques and methods. *J. Technical Edu.*, 34(12): 45 – 51.

The US Bureau of Labour Statistics 2018. A study of fatal injuries in metal fabrication industries. *News Release*, 45(12): 45 – 56.

United Nations 2018. World urbanization estimates and projections of major urban agglomeration. *United Nations Popul. Projections*, 34(16): 1045 – 1059.