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## **Evaluation of Occupational Noise Exposure within the Tequila Industry in Arandas, Jalisco**

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### **ABSTRACT**

**The tequila factory is one of the main economic activities of the municipality of Arandas, Jalisco in Mexico, as well as the surrounding municipalities, which makes it important, due to the number of people involved and the lack of quality medical services that are able to attend the problems arising from the exposure to high noise levels. Alongside the poor auditory culture in the community, industrial safety conditions regarding noise within the industry are not under proper observation; furthermore, existing regulations are very deficient to guarantee both health and auditory integrity of workers inside the workplace in the medium and long term. This study seeks to evaluate the occupational noise conditions existing within several companies of the tequila factory. For this evaluation, sound level meter were used to evaluate the general noise conditions in three different tequila factories. To carry out a complete analysis, standards regarding occupational noise from five developed countries were selected to compare such standards to the current local regulations. From this analysis, it was pursued to start the discussion regarding the working conditions of Mexico, starting from one of the industries of greatest export and economic income.**

**Keywords: Impulsive noises, Occupational health Occupational noise.**

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## **1. INTRODUCTION**

Currently in Mexico, as well as in several Latin American countries, there is very little knowledge and education about hearing health and little attention to regulations has been paid, and little interest that is given to the problem. In addition to this, the research that has been done on the physiological and psychological effects of uncontrolled noise levels emphasizes the need to create awareness in this topic increasing the economic, health and cultural benefits [1].

In order to understand this problem, it is necessary to consider that noise is a complex mixture of sounds with different frequencies, which are not pleasant to the ear. Noise pollution is a very important environmental factor in all developed and undeveloped countries since human activity has been concentrated in large industrial centers, causing a large increase in population. On the other hand, the industrialization has generated high levels of noise [2].

Noise measurements were carried out in three tequila factories in Arandas, Jalisco, to evaluate the acoustic levels. Even though the noise pollution is considered an occupational health problem, little attention has been paid to this problem. Since there are not information about the noise generated in the tequila factory, this research is the first intent to approach the problem and avoid different occupational diseases caused by noise pollution. The information will provide hard data, to approach the current situation for the tequila factory workers.

## **2. ARANDAS, JALISCO. GEOGRAPHIC LOCATION.**

Arandas, Jalisco is located at the North east of Jalisco, its population in 2015 was about 77,116 47.5 percent men and 52.5 percent women, the inhabitants of the municipality represented 19.3% of the total regional. Comparing the population from 2010 to 2015, the population increased about 5.9 percent in five years [3] [4].

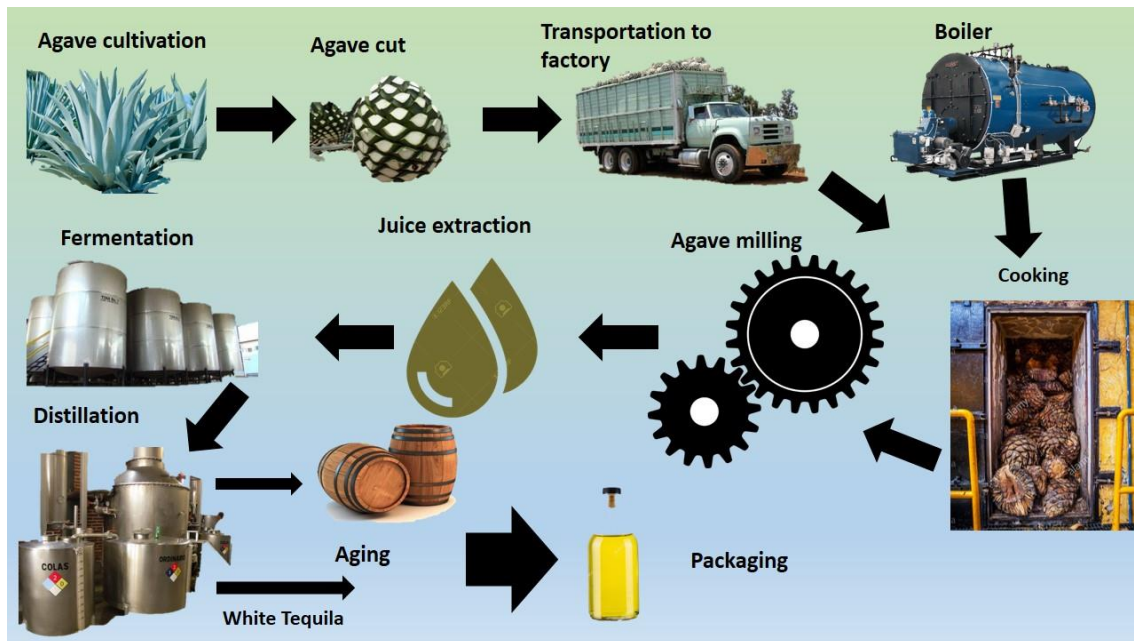


**Figure 1.** IIEG, "General Map of the State of Jalisco, 2012" [3]

### 3. TEQUILA INDUSTRY

Tequila is a drink with Denomination of Origin, which is elaborated from the fermentation and subsequent distillation of Agave azul (*Tequilana Weber*) variety sugars. Both, the tequila process production, and the cultivation of the Agave must occur within the territory determined in the Declaration of Protection of the Tequila Denomination of Origin. Besides, in order to name the drink "Tequila" its production must be carried out in strict compliance with the Official Mexican Standard for Tequila [5].

Because tequila has a designation of origin, can only be produce in some specific areas of Mexico such as the State of Jalisco (the whole state), 30 municipalities of Michoacán, 8 of Nayarit, 11 of Tamaulipas and 7 municipalities of Guanajuato. Arandas, is one of the main agave and tequila producers of Jalisco [6].



**Figure 2.** Tequila manufacturing process.

#### 4. REGULATIONS

Practically all legislation on the suppression of noise in workplaces indicates a maximum limit value of maximum sound level between 85 and 90 dB (A) for an exposure time of eight hours. This value is based on the guidelines of the international standard ISO 1999: 1990. The EU Directive 2003/10 / CE on risks of exposure to noise at work indicates a maximum limit value of 87 dB (A) for an eight-hour work day. France, Sweden, Norway, New Zealand and Spain allow 85 dB (A) for an eight-hour workday, with a reduction level in half of 3 dB (A).

OSHA 1910.95 Establishes the limit values for exposure to noise in the workplace. The limit values are based on the average value of a worker in an eight-hour workday. OSHA indicates the highest permissible exposure level, PEL (allowable exposure limit), of 90 dB (A) for all who work eight hours a day. These values are also valid for a half reduction level of 5 dB (A) [7] [8] [9] [10].

Mexican regulations: NOM-011-STPS-2001

In Mexico, there are normativity which establishes the standard conditions of safety and hygiene in workplaces where noise is generated. Due to its characteristics, levels and

time of action, noise may produce some negative impacts in the workers' health. The maximum levels and permissible exposure times per working day and their correlation are important factors to consider, this standard still has high noise levels compared with international regulations, for an 8-hour day, which is normally what is worked in Mexico (NOM-011-STPS-2001). Table 1, shows the Mexican standards for in industries [11].

**Table 1.** Maximum permissible exposure limits.

<b>Exposure level noise</b>	<b>Time</b>
<b>90 dB (A)</b>	<b>8 HOURS</b>
<b>93 dB (A)</b>	<b>4 HOURS</b>
<b>96 dB (A)</b>	<b>2 HOURS</b>
<b>99 dB (A)</b>	<b>1 HOUR</b>
<b>102 dB (A)</b>	<b>30 MINUTES</b>
<b>105 dB (A)</b>	<b>15 MINUTES</b>

## **5. METHODS**

### **5.1 Equipment**

The equipment used for the measurements of noise level was a TES-1352 A, its characteristics are as follows:

- Auto ranging
- 0.1dB Resolution
- Range from 30 to 130dB
- A&C Frequency Weighting
- Fast/Slow dynamic characteristic
- 16000 Records Data logging function
- RS-232 interface
- Real time clock with calendar

### **5.2 Variables**

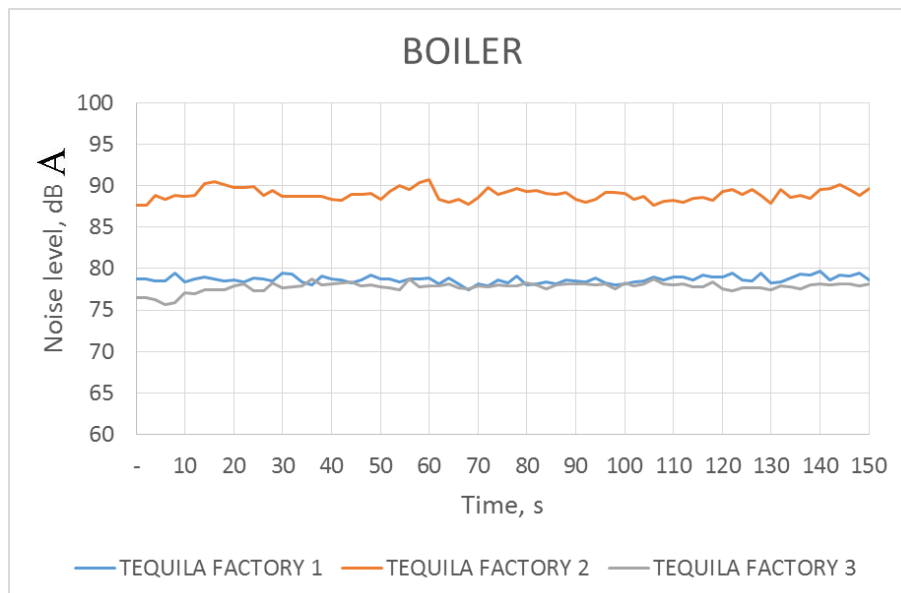
The variables that were considered are:

- Time of exposure to noise
- Sound pressure level (DBSPL)
- Location and process
- Equipment in the noise measurement area

Three tequila industries were chosen to carry out this study, it was considered the noisiest activities of the tequila production process, such as boiler, cooking, milling, fermentation, distillation and packaging. Three measurements were collected of each process, in a morning time, between 9 and 12 of the day, from January 21 to February 20, and a comparative analysis was made between the three tequila industries.

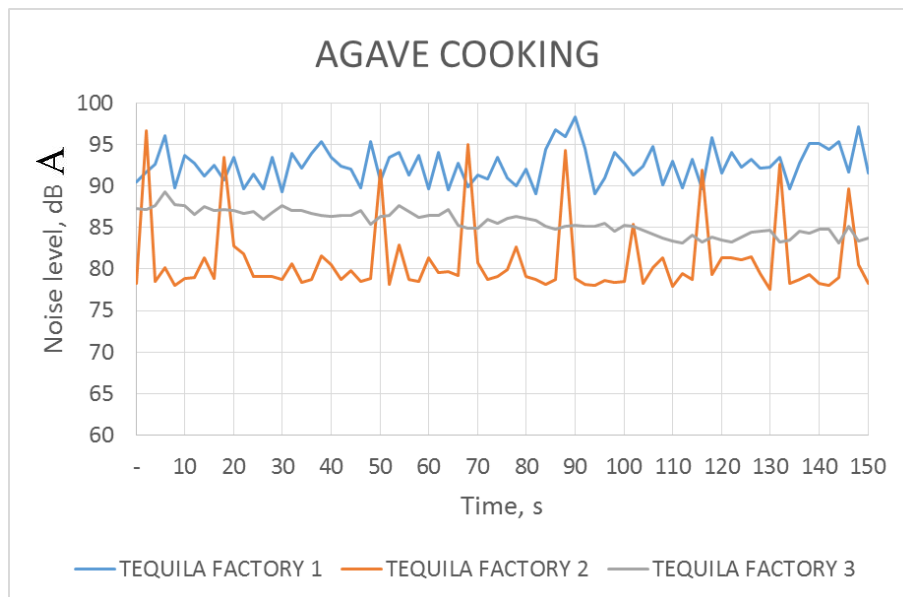
## 6. RESULTS

In Figure 3, there is a difference between the 3 tequila industries. The tequila factory (tequilera) number 2 presents a high level of noise due to the capacity (horsepower Hp) of the boiler; in addition, it also generates very high impulsive noises that surpass 95 dB. The other tequila industries handle a level of permissible noise; however, it is a high level to work without protection, thus it is necessary to use hearing protection in this area.



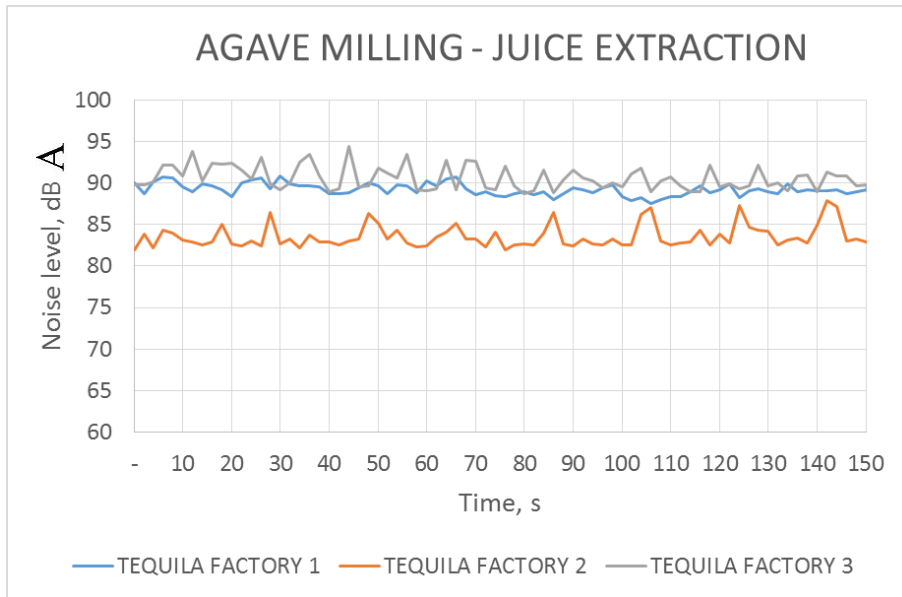
**Figure 3.** Noise level in boiler area for three different tequila factories in Arandas, Jalisco.

The results for the agave cooking area, are shown in Figure 4. The noise level depends on the vapor exhaust design and the bands that bring the raw material to the crushing area. The tequila factory 1 and 3, more stable noise level by part of the equipment was observed, since they have fewer ovens and bands. The problem of factory two is that the vapor exhaust generates high impulsive noise levels periodically, which can generate health problems for workers.



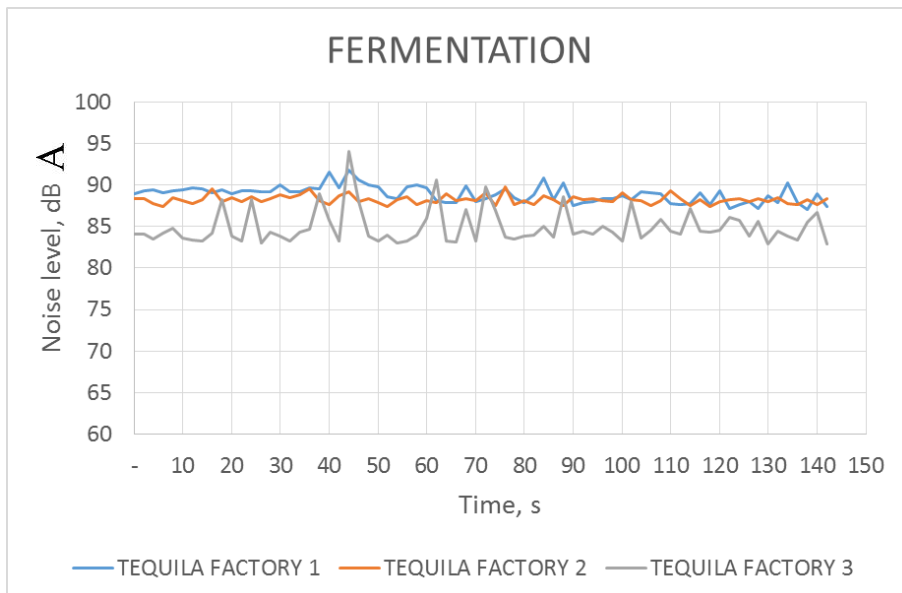
**Figure 4.** Noise level in agave cooking area for three different tequila factories in Arandas, Jalisco.

The results for the milling area are shown in Figure 5. The milling is the area with the noisiest equipment, in this area, the noise level depends on the design of each equipment, in the case of the tequila factory 2 does not exceed 90 dB, but generates a lot of impulsive noises, in the case of tequila factory 1 and 3, the average noise generated exceeds Mexican and international regulations.



**Figure 5.** Noise level in agave milling (agave juice extraction) area for three different tequila factories in Arandas, Jalisco.

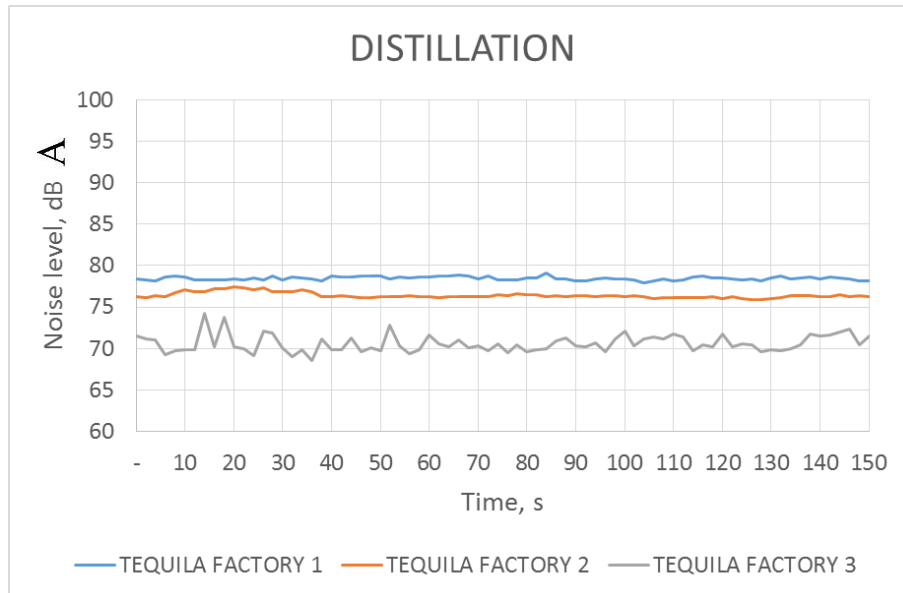
Results for the fermentation area are shown in Figure 6. This area is usually quiet, because the process is related with bacteria in the fermentation tanks of agave juice. However, in the same area the mix process take place and some noises level can be detected. In Figure 6, can be observed, impulsive noises continue to appear and remain at high levels.



**Figure 6.** Noise level in agave juice fermentation area for three different tequila factories in Arandas, Jalisco.

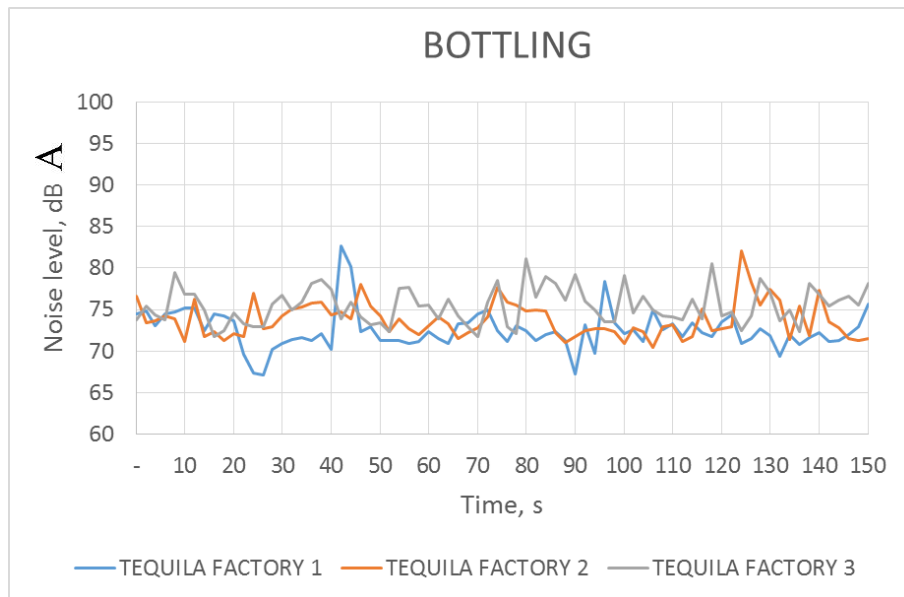


The noise levels in the distillation area (Figure 7) comply with Mexican and international regulations, even so, they have noise elevations caused by the equipment and the technique of the process; The alcoholic distillation is based on ethyl alcohol, it vaporizes at temperature below the boiling point of the water, thus the generation of vapors is one of the causes of the noise elevations.



**Figure 7.** Noise level in distillation area for three different tequila factories in Arandas, Jalisco.

In Figure 8, the effect of variable noise in bottling is shown. Even though the noise in this area is under the normativity limits, the physical contact between the bottles may cause high noises due to the constant movement.



**Figure 8.** Noise level in tequila bottling area for three different tequila factories in Arandas, Jalisco.

## 7. DISCUSSION

According to the results, the analysis of the implementation of industrial safety in the manufacturing companies of Arandas (Beltrán-Hernández, et al., 2018), the tequila industry complies with Mexican regulations NOM-011-STPS-2001. However, noise levels in the overall processes, were observed under the national regulations, still represent some risk in two particular areas, being these cooking and grinding, which measured very high levels, mainly from impulsive sources, that are related to problems of public health (Gómez, et al. 2012). The problem that affects the consortium includes the alteration of both physical and mental health, being this the aspect of major importance in this case, as well as the partial or total loss of the auditory capacity. It is important to take into account that the workers of the industries studied, they do not wear hearing protection; thus, exacerbating the problem of noise within the tequila industry, not only because of the inherent risk, but also due to the scarce or none follow-up that is given to it. [12][13]

## 8. CONCLUSIONS

The main problems in the tequila industry are impulsive noises, these noises can reach 98 dB, which generates health problems and low workers performance in this industry, as well as areas that exceeds the 90 dB level such as boiler, agave cooking and agave milling.

The main problem of industrial safety in Mexico is the low awareness and lack of attention to noise in the industry. All workers in the tequila factories in this research, had protection equipment to perform their work. However, they don't use hearing protection; causing concern to follow this study in detail, not only in the municipality of Arandas, but throughout the tequila production region.

## 9. REFERENCES

- [1] Sanz, Benjamín García; Garrido, Francisco Javier. La contaminación acústica en nuestras ciudades. Fundación "La Caixa", 2003..
- [2] De Esteban Alonso, Alfonso. Contaminación acústica y salud. Observatorio medioambiental, 2003, no 6, p. 73-95.
- [3] IIEG "Arandas: diagnóstico del municipio". 2018.
- [4] INEGI "Censo de población y vivienda". 2015.
- [5] López-López, A.; Davila-Vazquez, G.; León-Becerril, E.; Villegas-García, E.; Gallardo-Valdez, J. "Tequila vinasses: Generation and full scale treatment processes" Rev. Environ. Sci. Bio/Technol. (2010) Mexico.
- [6] CRT. Consejo Regulador del Tequila., Guadalajara, Jal., México. 2018.
- [7] S. E. Hse, "Controlling noise at workThe Control of Noise at Work Regulations 2005 Guidance on Regulations". 2005.
- [8] E. L. P. Europeo, E. L. Consejo, and D. E. L. A. Uni, "El parlamento europeo y el consejo de la unión europea, ," pp. 38–44, 2003.
- [9] A. O. F. Responsibilities, "OSHA 29 CFR 1910 . 95 - Occupational Noise Exposure," 1910.
- [10] "ISO 1999:1990 Acoustics - Determination of occupational noise exposure and estimation of noise-induced hearing impairment." .
- [11] D. Oficial, "NORMA Oficial Mexicana NOM-011-STPS-2001, Condiciones de seguridad e higiene en los centros de trabajo donde se genere ruido," *D. Of.*, pp. 1–29, 2002.
- [12] Beltrán-Hernández, C.; Barragán-Hernández, J.S.; Castañeda-Andrade, L.A. "Análisis de implementación de seguridad industrial en las empresas manufactureras de Arandas" Arandas, 2018.
- [13] Gómez-Martínez, M.; Jaramillo-García, J.J.; Ceballos, L.Y.; Martínez-Valencia, A.; Velásquez-Zapata, M, A.; Vásquez-Trespalcios, E, M. "Efectos en la salud de los trabajadores expuestos" Colombia, 2012.