

Evaluation of the concentration of particulate material and its impact on the respiratory diseases of the workers of an artesanal smelting huarochirí. Lima

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Resumen

Esta investigación tiene por objetivo principal determinar el nivel de concentración de material particulado del tamaño de 10 micras y 2.5 micras de una fundición artesanal, y evaluar la salud en las enfermedades respiratorias en los trabajadores, así mismo encontrar una relación entre el material particulado y las enfermedades respiratorias, el cual el proyecto se encuentra ubicado en el distrito de San Antonio, departamento de Huarochirí, departamento de Lima, Perú - 2017. Se utilizó el método de análisis gravimétrico aprobados por la Dirección General de Salud Ambiental DIGESA, con el "Protocolo de monitoreo de la calidad del aire y gestión de los datos", para determinar el nivel de concentración de material particulado, y por otra parte para las evaluaciones de salud en enfermedades respiratorias se utilizó una encuesta formulada por un doctor en neumología, el cual luego fue respalda por exámenes médicos realizados a los trabajadores. Se determinó que el material particulado de 10 micras y 2.5 micras estaban por encima de los estándares de calidad ambiental, el cual se considera como riesgoso para la salud de las personas, y en las enfermedades respiratorias se concluyó que algunos de los sujetos de la población de estudio se encuentran con enfermedades ocupacionales.

Palabras clave: Material Particulado, Enfermedades Respiratorias, Fundición Artesanal.

Abstract

The main objective of esta research is to determine the level of concentration of particulate materials of the size of 10 microns and 2.5 microns of an artisanal foundry, and to Evaluate the health in workers' respiratory diseases, as well as to find a relationship Between the particulate materials and the respiratory diseases, Which the project is located in the district of San Antonio, Department of Huarochiri, Department of Lima, Peru - 2017. The gravimetric analysis method approved by the General Directorate of Environmental Health DIGESA was used, with the Protocol for air quality monitoring and data management, to determine the level of concentration of particulate material and on the other hand Health Assessments in respiratory diseases Were used a survey made by a doctor in pulmonology, Which was Then backed by medical examinations performed on workers. It was Determined That the particulate materials of 10 microns and 2.5 microns Were above environmental quality standards, Which is Considered as risky for the health of people, and in respiratory diseases it was Concluded That some of the subjects of the population of study are With occupational diseases.

Keywords: Particulate Material, Respiratory Diseases, Artisanal Casting.

1. Introduction

The present study aims to demonstrate pollution emissions Particulate Matter PM10 and PM2.5 in the atmosphere that is generated in the smelting process at the artisanal level, with a cupola

furnace type and its impact on health in diseases respiratory workers in the rural community of Jicamarca San Antonio district, province of Huarochiri, Lima, Peru.

The development of this research was to conduct monitoring of air quality, which was used for assuring quality control and sample handling the Protocol Monitoring Air Quality and Data Management 2005, established by the General Directorate of Environmental Health (DIGESA), also the equipment used is the Particle Sampler high volume Hi - Vol. approved by US Environmental Protection Agency and to determine the health status of workers respiratory diseases medical examination was performed according to the Protocols of Occupational Medical Examinations and Diagnostic Guidelines of the compulsory medical examinations for Activity Approved by the RM No. 312-2011/MINSA.

2. Materials and Methods

Methodology for data collection Particulate Matter (PM10 and PM2.5), and Evaluation.

Material collecting suspended particulate is performed using a machine called high volume sampler Hi-Vol Brand Thermo Scientific Series P9350X and Model G10557PM10-1, which basically consists of a suction pump, a recorder, a slide flow filters and a programmer sampling time, also has additional equipment as a weather station and a Digital Pressure Gauge.

Monitoring was carried out according to the Protocol monitoring air quality and data management which was approved by the RD No. 1404-2005-DIGESA.

Methodology for collecting data on the impact of respiratory disease in workers

In collecting data for this variable consisted of the evaluation by a physician to all members of the sample examination and a technical document was used as a reference for the amount and effectiveness of evaluations: Protocols of Occupational Medical Examinations and Diagnostic Guidelines of Medical tests Required for Activity Approved RM No. 312-2011/MOH.

1. occupational medical examination; Occupational doctor determined the methodology and technology for medical evaluations according to the type of hazard exposure of the worker's activities, including medical examinations to be performed spirometry, chest X-ray and blood tests.

2. Questionnaire on health.

According to the nature of the investigation, the instruments are; informed consent for participation in the research sample, survey, data collection records (medical records), instruments and/or medical equipment, laboratory.

3. Results

Results of the concentration of particulate matter air quality.

Table 1 has valid results of monitoring air quality, where the particulate material 10 micron PM10 was performed 3 times, the average $147.69 \mu\text{m}^3$, although the failed because monitoring is observed rupture of the filter, monitoring particulate PM2.5, which resulted in $85.50 \mu\text{m}^3$ was also performed.

Data from the first monitoring air quality, which is important to calculate the concentration of particulate matter are; average temperature of 22.1°C , average humidity of 69.8%, average wind speed 1.8 m/s, Atmospheric Pressure Average 751.7 mmHg, and the wind direction with most predominant is the South-East.

Table 1. Result of monitoring air quality.

No.	particulates	Concentration ug / m ³ in 24hrs	Air ¹ Quality Standard (ECA)	Observation / Location	Concentration ug/m ³ in 12hrs ³
1st	PM10	126.18	1002	Location 01	252.35

2nd	PM10	39.33	1002	monitoring Failed 03	
3rd	PM10	124.39	1002	Location 01	248.77
4th	PM10	188.18	1002	Location 02	376.37
2nd	PM 2.5	85.50	252	Location 01	170.99

(1) Values in 24 hours mg/m³: Standard micrograms per cubic meter, (2) DS No. 003-2017-MINAM.
- Approved Environmental Quality Standards (ECA) Air and establish supplementary provisions, (3)
Table I was added because the day hard cast 8 to 10 hrs.

Results Average particle concentration Respirable Fraction

In Table 2, show eight monitoring results the average concentration of particles of respirable fraction, which is average is 1.69 mg/m³. The collection was also based on the gravimetric method NIOSH 0600.

Table 2. Monitoring Results Average Particle Concentration of Respirable fraction.

workers (Respirable Dust) Sample Code	Concentration Average (Nmg/m ³)	LMP (mg/ Nm ³)	workers (Respirable Dust) Sample Code	Concentration Average (Nmg/m ³)	LMP (mg/Nm ³)
PR - 01	0.82	3	PR - 05	0.96	3
PR - 02	0.62	3	PR - 06	2.81	3
PR - 03	2.04	3	PR - 07	1.61	3
PR - 04	2.86	3	PR - 08	1.85	3

Results of the survey of respiratory diseases.

The following tables show the descriptive statistics processing surveys conducted workers casting craft shows.

Polls show a first diagnosis of health in respiratory diseases, the following, the main signs, symptoms or diagnose indicators are; Asthma, pneumoconiosis, bronchitis and allergies.

Table 3 shows that the main symptoms of asthma are; Hacking cough and shortness of breath, which would be between little and often as rated frequency of Clinical survey - Environmental, which is deeply average 2.38 and 1.75 respectively. It also suggests that we the main symptoms of pneumoconiosis are tonsil inflammation, hoarseness, which occurs rarely as rated frequency of Clinical survey - Environmental, with an average of 1.63.

Table 3. Asthma frequency table and pneumoconiosis.

		ASTHMA					PNEUMOCONIOSIS				
		Dry cough	Sibilant. (Whistles)	Mucus. (expectoration)	Breathless ness (Agitation or fatigue)	Hacking cough	(Impatiens at rest or insomnia)	pulmonary disease (inflammation tonsils, hoarseness)	Difficulty breathing, shortness of breath	Weightl oss.	Chest pain (chest pain)
N	Valid	8	8	8	8	8	8	8	8	8	8
	lost	0	0	0	0	0	0	0	0	0	0
Half		1.50	1.00	1.50	1.75	2,38	75	1,63	1.00	1.0	75
ETS1		267	327	189	412	375	250	263	378	327	, 164
Median		1.00	1.00	1.50	1.50	2.50	1.00	1.50	1.00	1.0	1.00
fashion		1	1	the 1st	the 1st	3	1	1	0a	0a	1

FROM	756	, 926	, 535	1,165	1,061	, 707	744	1,069	, 926	463
variance	571	, 857	286	1,357	1,125	500	554	1,143	, 857	214
Rank	2	3	1	3	3	2	2	3	2	1
Minimum	1	0	1	0	1	0	1	0	0	0
Maximum	3	3	2	3	4	2	3	3	2	1
Sum	12	8	12	14	19	6	13	8	8	6

(1) STD: standard error of the mean (2): standard deviation

Table 4 shows the main symptoms of bronchitis are sneezing and coughing with mucus or phlegm, which occurs rarely as rated frequency of Clinical survey - Environmental, with an average of 1.88 in both cases. Also in this table, it makes us understand that the main symptoms of allergies are headaches (front), which would be between little and often as rated frequency of Clinical survey - Environmental, with an average of 2,63.

Table 4. Frequency table bronchitis, and allergies.

	Bronchitis					Allergies			
	gripa	sneezing	Irritated throat.	Mucus or phlegm cough	Runny nose.	Pain or sore throat.	Itchy nose.	Headaches. (front)	Sneezes.
N Valid	8	8	8	8	8	8	8	8	8
lost	0	0	0	0	0	0	0	0	0
Half	1,63	1,88	1,63	1,88	88	1,13	1,88	2,63	2.00
ETS1	263	, 295	324	, 295	125	, 295	, 398	324	267
Median	1.50	2.00	2.00	2.00	1.00	1.00	2.00	3.00	2.00
fashion	1	the 1st	2	2	1	the 1st	3	3	2
FROM	744	835	916	835	354	835	1,126	916	756
variance	554	, 696	, 839	, 696	125	, 696	1,268	, 839	571
Rank	2	2	3	3	1	2	3	3	2
Minimum	1	1	0	0	0	0	0	1	1
Maximum	3	3	3	3	1	2	3	4	3
Sum	13	fifteen	13	fifteen	7	9	fifteen	twenty-one	16

(1) STD: standard error of the mean (2): standard deviation

Results of medical examinations of respiratory diseases.

A summary of the medical examinations of workers are presented in Tables 5 and 6.

Table 5 shows a summary of the analysis performed in the clinical laboratory workers casting, you can also appreciate the reference values for greater interaction, on the other hand the boxes blank means that no analysis was not performed.

Table 5. Results of medical tests performed in the clinical laboratory.

Patient code	medical examinations							
	Hemoglobi n	Glucose	Urea	creatinin e	platelets	serum iron	Silicon	Lead
	vr	vr	vr	vr	vr	vr	vr	vr
	12-16 g/dL	70-110 mg/dL	15-39 mg/dL	0.8-1.3 mg/dL	1.5x10 ⁵ - 4.0 x10 ⁵ / mm ³	65-175 ug/dL	21-46 mg/day	40 ug/dL

P1	13.4	69	31	0.8	206000	-	-	-
P2	14	78	fifteen	0.7	280000	87	40	8.9
P3	12.6	79	22	0.7	296000	-	-	-
P4	14.1	67	30	0.7	173000	-	-	-
P5	13.6	79	37	0.8	166000	-	-	-
P6	14.5	78	30	0.7	206000	-	-	-

** vr reference values

Table 6 shows the evaluations and medical findings made by the pathologist, pulmonologist and radiologist workers artisanal foundry doctor.

Table 6. Results of medical examinations.

Code of patient	medical examination and analysis		
	Medical record	spirometry	Bone scan
P1	healthy adult	normal adult	No observations
P2	healthy adult	normal adult	No observations
P3	Acute bronchitis	normal adult	Bronchovascular increased frame to left dominance
P4	healthy adult	normal adult	No observations
P5	healthy adult	normal adult	Mild breast shutter left diaphragmatic cost
P6	healthy adult	normal adult	Presence of defined radiopacity 4x4 mm at the middle third of the left lung field

General Hypothesis Testing

Table 7 shows association between variables with a significance level of p-value (sig.) > 0.004, and the standard Pearson correlation is R = 0.880 between the particulate material and the impact on respiratory diseases workers of an artisan foundry.

Table 7. General assumptions, Application of linear correlation coefficient Pearson.

		Respirable dust	Survey respiratory diseases
Respirable dust	Pearson correlation	1	880 **
	Sig. (Bilateral)		004
	N	8	8
Survey respiratory diseases	Pearson correlation	880 **	1
	Sig. (Bilateral)	004	
	N	8	8

** . Correlation is significant at the 0.01 level (bilateral).

With regard to particulate matter average for PM10 is 147.6867 µg/m³ for a period of 24 hours, then it follows that exceed Environmental Quality Standards (ECA) currently required not exceeding 100 µg/m³ in 24 hours. Likewise exceeds 3 times the provisions reference to the World Health Organization (WHO) requires a period of 24 hours not exceed 50 µg/m³ therefore both references exceed permitted respect to air quality.

Following the monitoring of PM2.5 resulted in 85.50 µg/m³ over a period of 24 hours, exceeding permitted under the Environmental Quality Standards established by the MINAN setting a value of 50 µg/m³ over a period of 24 hours on the other hand exceeds 3 times the provisions of the World Health Organization (WHO) which requires a period of 24 hours not exceed 25 µg/m³ therefore both references exceed permitted respect to air quality.

4. Conclusions

It was found that there is a relationship a relationship between PM10 and PM2.5 Particulate Matter and respiratory diseases craft workers in a foundry, and concluding with the general hypothesis, using inferential statistics to test the linear correlation coefficient Pearson, we can say that there is an association between variables with a significance level of p-value 0.004, which would be well below the p-value of 0.05 is established as confidence interval 95%. Then the level Pearson correlation $R = + 0.880$ which is very close to +1.00 stating that the "positive correlation" and standing on a level of "high correlation" between the variables. Concluding then that the null hypothesis is rejected and the alternative hypothesis is accepted.

the concentration of particulate matter for PM10 and PM2.5 satisfactorily determined according to protocols established by the DIGESA, which gave PM10 average $147,687\mu\text{g}/\text{m}^3$, and PM2.5 gave $85.50\mu\text{g}/\text{m}^3$, then contrasting with the first specific hypothesis "single sample t" test where the average essential particulate material is collected, however, the environmental quality standards require applied is less than $100.00\mu\text{g}/\text{m}^3$ for PM10 and $50.00\mu\text{g}/\text{m}^3$ PM2.5 therefore means that are above the established standards in definition is concluded that the null hypothesis is rejected and the alternative hypothesis is accepted.

It was achieved assess the negative health impact on respiratory diseases artisanal foundry workers, and student t test of a sample and descriptive statistics for the second specific hypothesis was used; surveys, which gave an average result that there is a frequency between little and often indicators of asthma, bronchitis and allergies. And in contrast to the results of medical examinations substantial evidence that there are workers with lung disease was found, concluding that if "there is a negative health impact on respiratory diseases of workers of an artisan foundry" rejecting the null hypothesis and accepting the alternative hypothesis.

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