ONCOLOGÍA

**ISSN:** 2661-6653

**DOI:** https://doi.org/10.33821/781
**Article / Artículo**



# Characteristics of asbestos exposure in employees of a company in Azuay - Ecuador

## Características de la exposición al amianto en los empleados de una empresa en Azuay, Ecuador

Juan Vázquez Andrade & Denisse Escandón Quezada

University of Cuenca

**Received:** 12/12/2024
**Accepted:** 28/03/2025
**Published:** 30/04/2025

**ABSTRACT**
**Background:** Asbestos or amianto which can cause cancer and lung diseases such as asbestosis, according to the WHO, are still used to make fiber cement. This puts workers at risk of respiratory problems in the short, medium, and long term. **Objective:** The aim of this study is to determine the characteristics of asbestos exposure in workers of a company in the city of Cuenca - Azuay, Ecuador during the period 2022-2023. **Materials and methods:** Observational, descriptive, cross-sectional study, including a total of 25 workers. Four processes were carried out: collection of demographic data, review of the morbidity and absenteeism matrix, collection of environmental samples for asbestos analysis, and verification of compliance with biosafety measures by means of a check-list. Subsequently, data were entered into Microsoft Excel and analyzed using statistical methods such as mean, median, and mode. **Results:** It was found that 84% of the studied population had not completed secondary school, and 60% were between 18 and 31 years of age. The rate of absenteeism was 1.35% due to respiratory tract diseases. All workers are exposed to asbestos (0.35 f/cc; 0.45 f/cc). Finally, 60% of the population does not adequately comply with biosafety measures. **Conclusions:** This study identified a population at high risk of asbestos exposure, who, in addition, lack adequate personal protective measures. Although this exposure could have contributed to the rate of absenteeism due to respiratory tract diseases, it is not possible to establish a direct proportional relationship.

**Keywords:** Asbestos, asbestosis, pneumoconiosis.

**RESUMEN**
**Antecedentes:** El amianto o asbesto, que según la Organización Mundial de la Salud puede causar cáncer y enfermedades pulmonares como la asbestosis, todavía se usa para hacer fibrocemento. Esto pone a los trabajadores en riesgo de sufrir problemas respiratorios a corto, mediano y largo plazo. El objetivo de este estudio fue determinar las características de la exposición al asbesto en los trabajadores de una empresa en la ciudad de Cuenca, Azuay, Ecuador, durante el 2022-2023. **Materiales y métodos:** Estudio descriptivo observacional, de corte transversal, que incluyó un total de 25 trabajadores. Se llevaron a cabo cuatro procesos: 1) recolección de datos demográficos, 2) revisión de la matriz de morbilidad y de ausentismo laboral, 3) toma de muestras ambientales para análisis de amianto y 4) verificación del cumplimiento de medidas de bioseguridad mediante una lista de chequeo. Posteriormente, los datos se ingresaron a Microsoft Excel y se analizaron utilizando métodos estadísticos como media, mediana y moda. **Resultados:** Se evidenció que el 84 % de la población estudiada no ha cursado la secundaria y el 60 % tiene un rango de edad entre 18 y 31 años. El índice de

*** Corresponding Author:** Dr. Juan Vázquez Andrade, juandiego1313@hotmail.com

**How to cite:** Vázquez Andrade J, Escandón Quezada D. Characteristics of asbestos exposure in employees of a company in Azuay - Ecuador. Oncología (Ecuador). 2025;35(1): 48-56. https://doi.org/10.33821/781

ausentismo laboral fue de 1,35 % por enfermedades del tracto respiratorio. Todos los trabajadores se encuentran expuestos al amianto (0,35 f/cc; 0,45 f/cc). El 60 % de la población no cumple adecuadamente con las medidas de bioseguridad. **Conclusiones:** Este estudio identificó una población con alto riesgo de exposición al amianto, la cual, además, carece de las medidas adecuadas de protección personal. Aunque esta exposición podría haber contribuido al índice de ausentismo por enfermedades del tracto respiratorio, no se puede establecer una relación directamente proporcional.

**Palabras Clave:** amianto, asbestosis, pneumoconiosis.

## 1. Introduction

Asbestos is a group of fibrous minerals made up of double-chain silicates, they are naturally found in nature and have various commercial uses in different types of industry including construction, automotive, textile, electrical, chemical, and demolition work [1]. Asbestos is also known as *amianto* in some regions of America and are divided into two classes: serpentines, which are flexible, elongated and coiled fibers; and amphiboles, which are short, straight, rigid, and generally sharp fibers [2]. Among the serpentines, there are chrysotile, a hydrated magnesium silicate, grey-white in color; amphiboles, including crocidolite, iron and sodium silicates (blue asbestos); anthophyllite, including magnesium silicates; tremolite including calcium and magnesium silicates; amosite and actinolite [3]. Due to their fibrous characteristics, asbestos can cause three types of respiratory pathologies in the organism: asbestosis or alveolar fibrosis, lung cancer, and the appearance of mesotheliomas or cancers in the pleura and other endothelia [4]. The World Health Organization (WHO) considers that there is sufficient evidence to classify all types of asbestos as carcinogenic for humans who are exposed to them in different industries without any protective barriers or controls at the source, in the environment or in the person [5]. In Latin American countries such as Argentina, Colombia, and Peru, there are restrictions on the use of asbestos due to the serious health problems it has caused in the working population, especially in construction activities, as well as in the air near emitting points or inside homes and premises built with friable materials containing asbestos. The WHO mentions that there are about 125 million people exposed in the workplace and that 107,000 people die each year due to chronic respiratory pathologies developed as a result of this exposure. Unfortunately, these pathologies develop after continuous and prolonged exposure and do not necessarily present symptoms in primary and secondary prevention stages, but in a tertiary stage where the disease is already developed and it is incurable. In Ecuador, the use of asbestos is permitted. There is little information about this fiber; however, the Ecuadorian Technical Regulation of the Ecuadorian Institute of Standardization RT INEN 052: 2011 mentions mandatory guidelines on safety and health in work activities related to their use. It is vital to investigate the exposure to asbestos in depth given the serious consequences on the health of workers, especially in the construction sector where people start their working life at a very early age and without any protective barrier. The main objective of this study is to determine the characteristics of asbestos exposure in a small population of a construction company operating in the country through a descriptive study. Through the identification of risk factors using the triple criteria matrix method of the National Institute for Safety and Health at Work (INSST) and the implementation of Operational Hygiene, environmental monitoring was carried out to determine objectively whether there is a hygienic risk for the exposed workers. Results were compared with the threshold limit value (TLV)-time-weighted average (TWA) of the American Conference of Governmental Industrial Hygienists (ACGIH) for an exposure of eight hours. It was complemented by an analysis of health surveillance with respect to the rate of absenteeism and monthly morbidity of workers. In Ecuador, the relationship between workers' compliance with biosafety measures and exposure to certain chemical compounds such as asbestos has not been sufficiently studied. This study could contribute to filling this gap, which has been underestimated in the country, and highlight the importance of research in this area, urging the adoption of preventive and protective measures for the worker.

## 2. Materials and methods

### 2.1 Study Design

This is an observational, descriptive, cross-sectional study.

### 2.2 Population and Sample

Given the small number of workers exposed to asbestos in the company where the study was carried out, a census sample was chosen, including the 25 workers exposed in the period 2022-2023.

### 2.3 Inclusion Criteria

- Workers with documented exposure to asbestos.
- Aged between 18 and 65 years old.
- Both sexes.
- At least 3 months of seniority in the company.

### 2.4 Exclusion Criteria

- Workers who did not give informed consent.
- History of chronic pulmonary pathology other than occupational exposure.

### 2.5 Study Variables

- **Socio-demographic data:** sex, age, educational attainment.
- **Absenteeism rate:** total hours of absence due to morbidity in relation to the established working hours.
- **Asbestos monitoring:** environmental concentration of asbestos fibers (f/cc).
- **Compliance with biosecurity measures:** use of personal protective equipment and preventive measures.

### 2.6 Procedures and Data Collection

The study was approved by the Committee on Ethics and Research in Human Health (CEISH) with the code 2023-024-MST-MLF (Oficio No. CEISH-UC-2023-096). Subsequently, data collection was carried out using the following techniques:

1. Structured interview and validated questionnaire:

- Individually applied after informed consent.
- It contained questions on socio-demographic data and working conditions.

2. Structured observation:

- The absenteeism rate was assessed using monthly company records.
- A morbidity and absenteeism matrix were used.

3. Environmental monitoring of asbestos:

- It was carried out on 12 May 2023 in collaboration with ABGES Environmental Analytic Laboratory Cia Ltda.
- A vacuum pump with membrane filter and phase contrast optical microscopy were used.
- Results were expressed in fibers per cubic centimeter of air (f/cc) and compared with the limits set by ACGIH and NIOSH.

4. Assessment of biosecurity compliance:

- A 12-item checklist was applied.

- Eight items on respiratory protection, one on body protection, and three on other equipment were included.

5. Occupational risk assessment:

- The methodology of the Spanish National Institute for Safety and Health at Work (INSST) was used.
- Risks were classified according to likelihood of exposure and expected consequences.

### 2.7 Data Analysis

The collected data were entered into Microsoft Excel 2016 and analyzed using descriptive statistics, calculating frequencies and percentages for qualitative variables. Results of the environmental monitoring were compared with international references.

### 2.8 Ethical Considerations

Data confidentiality was ensured by anonymous identification codes. All participants gave informed consent prior to inclusion in the study.

## 3. Results

### 3.1 Socio-demographic characteristics

The socio-demographic characteristics of workers included in the study are detailed in Table 1. The entire sample (n = 25) was composed of men. Sixty per cent of the participants were between 18 and 30 years old. With regard to educational attainment, 40% did not complete basic education and 8% did not complete secondary education.

**Table 1.** Demographic variables

| Variables | | F | % |
|---|---|---|---|
| Age Ranges | 18 to 30 | 15 | 60 |
| | 31 to 45 | 7 | 28 |
| | 46 to 65 | 3 | 12 |
| Sex | Male | 25 | 100 |
| Educational attainment | None | 2 | 8 |
| | Incomplete basic education | 10 | 40 |
| | Complete basic education | 9 | 36 |
| | Bachelor's degree | 4 | 16 |

Source: Author

### 3.2 Rate of absenteeism due to illness

The rate of absenteeism due to respiratory tract diseases was 1.35%, higher than the 0.25% recorded for digestive tract diseases. The total all-cause absenteeism rate reached 2.05%. Despite the higher incidence of absenteeism due to respiratory diseases, a direct relationship with asbestos exposure cannot be established without considering other factors.

**Table 2.** Comparison of absenteeism and morbidity

| Disease | Absenteeism rate (%) |
|---|---|
| Digestive tract | 0.25 |
| Respiratory tract | 1.35 |
| Musculoskeletal | 0.1 |
| COVID-19 | 0.25 |
| Other | 0.1 |
| **Total** | **2.05** |

Source: Author

### 3.3 Environmental monitoring of asbestos

The environmental measurement determined that workers were exposed for approximately 8 hours per day, accumulating 40 hours per week and 160 hours per month. The weighted asbestos concentrations were 0.45 f/cc in the cement hopper and 0.35 f/cc in the operating cabin. These figures exceed the permissible exposure limit (0.1 f/cc) established by NIOSH and ACGIH, thus indicating an intolerable risk according to INSST criteria.

**Table 3.** Monitoring of asbestos in a cement hopper

| Parameter | Value |
|---|---|
| Concentration 15 min | 0.35 f/cc |
| Weighted concentration (8h) | 0.45 f/cc |
| NIOSH/ACGIH Limit | 0.1 f/cc |
| **Risk level** | **Intolerable** |

**Table 4.** Asbestos monitoring in operator's cabs

| Parameter | Value |
|---|---|
| Concentration 15 min | 0.25 f/cc |
| Weighted concentration (8h) | 0.35 f/cc |
| NIOSH/ACGIH Limit | 0.1 f/cc |
| **Risk level** | **Intolerable** |

### 3.4 Compliance with occupational health and safety measures

The analysis of current regulatory compliance (Standard 044/2022) at the company revealed deficiencies in technical management and basic process control, both with a moderate risk of 25% and 30%. This shows a lack of adequate corrective measures to reduce the risk of asbestos exposure.

**Table 5.** Level of risk in compliance with regulations

| Management area | High risk | Moderate risk | Low risk | No risk |
|---|---|---|---|---|
| Documentary management | - | - | 15% | - |
| Technical management | - | 25% | - | - |
| Basic process control | - | 30% | - | - |
| Administrative management | - | - | 30% | - |

### 3.5 Use of personal protective equipment

In relation to the use of personal protective equipment, it was found that 52% of the workers used an N95 mask, while 48% did not use any type of respiratory protection. As for hand protection, 68% used nylon gloves with polyurethane coating. No workers used adequate body protection equipment, such as airtight suits or boots. In addition, a general lack of knowledge about the use and replacement of protective equipment was identified.

These findings show deficiencies in the implementation of occupational health and safety measures, which represent a continuing risk for workers exposed to asbestos.

**Table 6.** Use of personal protective equipment

| Type of protection | Indicator | Yes (%) | No (%) |
|---|---|---|---|
| Respiratory | Mask N95 | 52 | - |
| | None | - | 48 |
| Hands | Coated nylon gloves | 68 | - |
| | None | - | 32 |
| Corporal | Airtight suit | 0 | 100 |
| | Safety boots | 0 | 100 |

## 4. Discussion

Exposure to asbestos without adequate protection or above safe working limits causes serious lung diseases such as asbestosis, mesothelioma, and various types of cancer [6]. This study analyzed 25 construction workers by assessing socio-demographic factors, shared responsibility for protective equipment, levels of asbestos fibers in the work environment, and their possible relationship with absenteeism.

A study conducted by Donostia (2018) analyzed 55 patients exposed to asbestos, being 98% men and 2% women, all older than 55 years [7]. The University of Valladolid reported that, in 2016, 8 people developed occupational diseases from asbestos dust and 14 from related carcinogens, all men aged 20-45 years with incomplete education [8]. The current study shows that all participants are men (100%) between 18-65 years old, 60% of them are under 30 years old, being a younger population than in previous studies, and 84% did not complete secondary education.

A 1987 Serbian study of workers in an asbestos textile factory showed significantly higher rates of absenteeism than the control group over four years, with rates for respiratory diseases ranging from 99-117.4 versus 22.9 for the control group [9]. The current study shows a similar correlation, with absenteeism due to respiratory diseases accounting for 1.35%, being the most frequent cause of absence from work.

Although 1.35% seems low, it is the highest rate among all causes of absenteeism in the population studied, which could indicate a future increase for this reason.

The study detected asbestos levels of 0.45f/cm$^3$ in the cement hopper and 0.35f/cm$^3$ in the operating cabin, exceeding the ACGIH limits. This is evidence of the lack of control in Ecuador compared to developed countries such as the USA, where a 2011 study in mechanics showed concentrations between 0.005-0.049f/cc, well below the permitted limit [10]. A Slovakian study from 2020 measured asbestos fibers during demolition of asbestos-cement buildings, finding concentrations between 0.010-0.020 f/cm$^3$, with the highest values during demolition, but still well below the permitted limits [11]. Both studies showed asbestos concentrations significantly lower than those found in the present study and below the limits set by ACGIH.

A 2013 Iranian study assessed asbestos exposure during demolitions of old houses, detecting levels between 0.02-0.42 f/cm$^3$ by optical microscopy, considerably higher than the limits set by ACGIH [12]; both studies, although in different contexts, analyzed construction workers using the same methodology and found asbestos levels above safe limits. This suggests that, in the construction sector in developing countries such as Ecuador and Iran, exposure levels are still not adequately controlled, and that it will take years to effectively implement international regulations to reduce asbestos-related occupational diseases.

A study conducted in Quito, Ecuador, on environmental exposure to asbestos in residents near an industrial plant detected by optical microscopy 443 asbestos fibers in the first filter and 221.5 in the second [13]. This study, although not conducted in the construction sector, highlights the importance of implementing continuous monitoring and measurements in both construction companies and factories using asbestos-containing materials.

There is currently no literature that verifies compliance with biosafety measures in workers exposed to asbestos. This study proposes to compare the actual use of personal protective equipment with the recommendations of articles, good practice guides, and current legislation on asbestos management.

In this study, only 52% of workers wore N95 masks and 68% wore nylon gloves with polyurethane, while the rest did not use protection. This is evidence of company negligence, since according to Royal Decree 773/1997, employers must identify positions requiring protection, select suitable equipment, provide it free of charge, replace it when necessary, and ensure its correct use and maintenance [14].

According to Royal Decree 396/2006, workers must wear personal protective equipment, especially respiratory protective equipment, even when asbestos exposure limits are not exceeded, for two reasons: any exposure, no matter how small, represents a risk, and in work environments the absence of unforeseen accidental exposure cannot be guaranteed [15,16].

The INSST recommends different respiratory protection equipment according to duration and concentration: for short work at levels below the Environmental Limit Value (VLA), FFP3 masks or adapters with P3 filters; for concentrations not exceeding the VLA, facepieces with P3 filters; for levels exceeding the VLA, filtering equipment with assisted ventilation (TMP3/THP3); and for concentrations much higher than the VLA, semi-autonomous or autonomous compressed air isolation equipment [14-16]. Company employees did not use even the minimum recommended respiratory protective equipment, even in situations where exposure levels could be low.

Appropriate protective clothing must prevent the penetration of asbestos fibers, cover the whole body, comply with European classification, be certified according to RD 1407/1992 and CE marked. It is crucial to follow the manufacturer's instructions on use, maintenance and compatibility with another PPE. The suits can be disposable or reusable, requiring specific protocols for disposal or decontamination, and workers must keep them on throughout the exposure [15]. They also did not use the basic body protective equipment recommended in the literature, such as airtight clothing and appropriate gloves.

The Agreement N° 0100 in Ecuador regulates safety for the handling of asbestos, requiring adequate protective equipment and a respiratory protection program to be developed with technical advice from IESS, but does not specify the types of equipment to be used [17-19].

## 5. Conclusions

The study characterized asbestos exposure in 25 masonry workers, evaluating specific tasks, biosafety measures, absenteeism, and fiber concentration in the environment. It is recommended to replace fiber cement with asbestos-free alternatives or to reinforce controls at source, environment, and people. In addition, it is essential to improve ventilation, provide adequate protective equipment, train workers, and carry out regular environmental assessments to ensure regulatory compliance and early detection of diseases associated with exposure.

## 6. Abbreviations

- **ACGIH** Conference of Governmental Industrial Hygienists
- **TLV** Threshold Limit Values
- **VLA** Environmental Limit Value
- **TWA** Time – Weighted Average

# 7. Administrative Information

## 7.1 Additional Files

None


## 7.2 Acknowledgments

I thank my family for their unconditional support.


## 7.3 Contributions of the Authors

The authors declare that the responsibilities contributed to the article are described using the CRediT taxonomy. Conceptualization: V.J.; data curation: V.J. and E.D.; formal analysis: V.J. research and methodology: V.J. and E.D.; project management: V.J.; software: V.J.; writing - original draft: V.J.; supervision: E.D.; validation: V.J. and E.D.; visualization: E.D.; writing - revision: E.D.; editing V-J. And E.D.; The authors declare that this research was self-financed and did not receive financial support from any public or private entity.


## 7.4 Funding

This research was carried out with own funds and did not receive funding from any entity, either public or private.


## 7.5 Data and Material Availability

Data is available upon request to the corresponding author. No other materials are reported.

# 8. Declarations

## 8.1 Conflict of Interest

The author declares no conflicts of interest.

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