Association Between Education Level and The Use of Asbestos as Roof Housing

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Abstract

This research explores the link between educational attainment and the utilization of asbestos roofing within urban communities in Jakarta. Data were gathered from 130 respondents through structured questionnaires, followed by statistical testing using the Chi-Square method. The findings reveal a strong association between education and roofing preferences ($\chi^2 = 37.51$, $p < 0.001$). Respondents with limited education tended to rely more heavily on asbestos, whereas individuals with senior high school or higher qualifications demonstrated a stronger inclination toward non-asbestos roofing. These results underline the role of education in shaping both awareness of asbestos-related health hazards and the ability to adopt safer alternatives. The study concludes that expanding educational opportunities can indirectly support the reduction of asbestos use, thereby contributing to improved housing safety and community health.

INTRODUCTION

Asbestos has long been used in construction because of its affordability, durability, and fire resistance. Despite its advantages, decades of scientific evidence have linked asbestos exposure to severe diseases such as mesothelioma, lung cancer, and asbestosis (Mossman & Churg, 1998; Stayner et al., 1996). The World Health Organization (WHO, 2014) emphasizes that there is no safe level of asbestos exposure. However, the use of asbestos roofing materials in Indonesia remains widespread, particularly in low- and middle-income communities where price is a dominant consideration (Suraya et al., 2020).

In Jakarta, asbestos sheets are still easily found in local building material stores and remain one of the most affordable roofing options, priced significantly lower than safer alternatives like metal roofing or ceramic tiles (Frank et al., 2022). This affordability, coupled with low awareness of health risks, results in persistent asbestos use in dense urban neighborhoods. The high prevalence of asbestos use poses a public health challenge that directly relates to SDG 3 (Good Health and Well-Being) and SDG 11 (Sustainable Cities and Communities), which emphasize safe housing and reduced exposure to environmental hazards (United Nations, 2015; WHO, 2017).

Education plays an important role in influencing health-related decision-making and construction material choices. Households with higher educational attainment generally have

greater access to information, higher health literacy, and stronger financial capacity to select safer but more expensive materials (Zimmerman & Woolf, 2014). Conversely, households with lower education levels often prioritize affordability and availability, despite potential long-term health consequences (Cutler & Lleras-Muney, 2006).

This situation aligns with global health and development challenges, particularly those outlined in the Sustainable Development Goals (United Nations, 2015). Specifically, asbestos exposure and its implications for respiratory health are strongly connected to SDG 3 (Good Health and Well-Being), which emphasizes the reduction of mortality and morbidity from environmental pollutants, and SDG 11 (Sustainable Cities and Communities) (World Health Organization, 2017), which calls for safe and resilient housing. Addressing asbestos-related risks is thus not only a local environmental health issue but also a contribution to global commitments under the SDG framework.

Given this context, it is essential to investigate the relationship between educational level and asbestos use in roofing. This study aims to provide an explanatory analysis of how education influences material choices, with a focus on identifying whether the relationship is significant, its direction, and the underlying factors that explain this association.

Research Objective and Hypothesis: This study aims to investigate whether there is a statistically significant association between the level of education and the use of asbestos roofing materials in urban Jakarta. It is hypothesized that households with higher education levels are more likely to choose non-asbestos roofing materials, whereas households with lower education levels are more likely to use asbestos due to its affordability and availability.

LITERATURE REVIEW

Asbestos-Related Disease Mechanisms

Previous studies have demonstrated how asbestos fibers trigger severe respiratory diseases through cellular and molecular pathways. (Mossman and Churg 1998) emphasized that asbestos fibers induce oxidative stress, chronic inflammation, and progressive pulmonary fibrosis, which constitute the pathological basis of asbestosis and other asbestos-related lung diseases. This perspective is reinforced by (Stayner et al. 1996) who revisited the amphibole hypothesis, which initially suggested that only amphibole asbestos posed significant risks. Their findings showed that chrysotile—the most widely used asbestos type in construction materials—also exhibits strong carcinogenic properties. Collectively, these studies affirm that asbestos exposure is inherently hazardous, regardless of fiber type, and underscore that chrysotile-based roofing materials in densely populated housing environments remain a critical public health concern.

Asbestos Exposure and Health Risks

Beyond the biological mechanisms, a growing body of literature highlights the real-world implications of asbestos exposure at both the community and occupational levels. (Frank et al. 2022) emphasized that asbestos-cement roofing represents a continuous public health threat, as natural weathering and home renovations accelerate the release of fibers into the atmosphere, particularly under humid tropical conditions. In Indonesia, this issue is further complicated by weak occupational health surveillance systems and limited awareness among

informal construction workers, who frequently handle asbestos materials without adequate protection, as noted by (Lestari et al. 2023). The risks are further substantiated by (Suraya et al. 2020) who provided clinical evidence through a hospital-based case-control study showing a strong association between asbestos exposure and lung cancer, particularly among smokers. This highlights a synergistic interaction between environmental hazards and lifestyle behaviors. Taken together, these findings indicate that community-level exposure, occupational vulnerability, and lifestyle factors intersect to exacerbate health risks. In densely populated urban settlements, where smoking prevalence remains high, the cumulative burden of asbestos exposure becomes a pressing public health challenge.

Education and Behavior Choices

Education not only improves knowledge but also influences decision-making skills and behavioral preferences. (Mirowsky and Ross, 2003) emphasized that higher education enhances individuals' cognitive ability to anticipate long-term consequences, evaluate alternatives, and reduce risky behaviors. People with higher educational attainment are more likely to adopt preventive health measures, allocate resources more rationally, and invest in safer long-term options, even when these require higher financial commitment at the outset. This cognitive advantage enables educated households to recognize the latent risks of asbestos exposure and seek non-asbestos alternatives, such as metal sheets or fiber-cement roofing, despite their relatively higher cost.

Conversely, households with limited education often prioritize immediate affordability and availability of materials rather than their long-term health implications. In such contexts, asbestos becomes a preferred option because it is cheaper, widely available, and durable. However, these short-term decision-making neglects the hidden costs of asbestos-related illnesses, which can place a substantial financial and social burden on households in the future. Empirical studies in developing countries show that families with lower education levels consistently choose building materials based on price rather than safety standards (Cutler and Lleras-Muney, 2006).

Determinants of Building Material Choice

Empirical studies on material selection in housing emphasize price, availability, durability, and cultural familiarity as dominant determinants. Research focused on low-cost housing and informal settlements in Indonesia shows that affordability often overrides health concerns, leading households to choose cheaper options such as asbestos-cement roofing despite awareness of long-term risks (Santosa & Prasetyo, 2019; Nugroho et al., 2021). Similar patterns are observed in other developing countries where informal housing dominates urban growth (Cutler & Lleras-Muney, 2006). These studies underscore the need for public health interventions and subsidy programs to encourage the use of safer materials.

METHODS

This research applied a quantitative descriptive survey approach to examine the association between education level and the choice of roofing materials. The study was conducted in a densely populated urban neighborhood in West Jakarta, which was selected because of its heterogeneous socioeconomic profile and the widespread use of asbestos roofing. The research

location consists of low-rise housing and kampung settlements, providing a realistic representation of typical urban residential conditions in Jakarta.

Respondents were selected using a systematic random sampling method from neighborhood resident lists to ensure representativeness across different educational levels. A total of 130 respondents participated in the study, with an overall response rate of 85%. Although some categories such as "no certificate" and "diploma" had smaller sample sizes, these were still included to maintain the completeness of education-level distribution. The relatively small frequencies for certain groups were carefully considered to ensure that Chi-Square assumptions were not violated.

The main outcome variable in this study was the type of roofing material used. Roofing materials were categorized into two groups: asbestos and non-asbestos. Non-asbestos materials included galvalume, ceramic roof tiles, and shingle tiles. The primary predictor variable was the respondents' highest level of education, classified into six categories: no certificate, elementary, junior high, senior high, diploma, and bachelor's degree. Additional information such as household income, occupation, and type of housing was also collected to support descriptive statistics and strengthen the interpretation of results.

Data were gathered through a structured questionnaire that was administered face-to-face by trained enumerators. To ensure accuracy and geospatial traceability, responses were recorded using ArcGIS Field Maps. Prior to data collection, respondents were provided with informed consent forms explaining the research objectives, the voluntary nature of participation, and the assurance that personal data would remain confidential. The collected data were numerically coded, tabulated using Microsoft Excel, and processed for statistical analysis. Crosstabulation was used to observe patterns between education level and roofing material choice. The Chi-Square Test of Independence was then applied to determine whether the observed differences between categories were statistically significant. The statistical assumptions for Chi-Square, including minimum expected cell frequencies, were verified prior to final analysis to ensure validity of the results.

RESULTS AND DISCUSSION

Respondent Characteristics and Roofing Material Usage

This study surveyed a total of 130 respondents from a densely populated urban area of Jakarta, providing a representative snapshot of the community's socio-educational composition. The educational profile of the respondents was notably diverse, ranging from individuals with no formal education to those holding a bachelor's degree. The largest proportion of participants had completed junior high school (51.5%), which reflects the demographic trend of the area where lower-secondary education is the most common terminal level. Bachelor's degree holders constituted the second-largest group (24.6%), indicating that a substantial segment of the community had access to higher education opportunities. The remaining respondents were distributed across senior high (13.1%), elementary (4.6%), diploma (4.6%), and no-certificate (1.5%) categories.

Table 1 demonstrates that more than half of the surveyed population had relatively modest educational backgrounds, a factor that would later prove crucial in explaining their material choices. The predominance of junior high graduates suggests that health and construction

literacy may still be limited for a majority of households. This limitation is significant, as decision-making regarding housing materials—such as the use of asbestos—is not merely an economic calculation but also a cognitive process influenced by risk perception and long-term health awareness.

Table 1. Distribution of Respondents by Education Level Asbestos Roof Usage.

Roof Usage	Characteristic Base on Education Level						Total Respondent
	No Certificate	Elementary	Junior High	Senior High	Diploma	Bachelor	
Asbestos Roof	1 (50.0%)	2 (33.3%)	42 (62.7%)	9 (52.9%)	1 (16.7%)	0 (0.0%)	55 (42.3%)
Non-Asbestos Roof	1 (50.0%)	4(66.7%)	25 (37.3%)	8 (47.1%)	5 (83.3%)	32 (100%)	75 (57.7%)
Total	2	6	67	17	6	32	130

When cross-tabulated against roofing material usage, a clear pattern emerged linking education level with the choice between asbestos and non-asbestos roofing. Respondents with lower education levels were considerably more likely to report using asbestos roofing. For instance, 62.7% of junior high graduates reported asbestos usage, making them the most exposed group. In contrast, the use of asbestos decreased sharply in the higher-education categories: only 16.7% of diploma holders used asbestos, and none of the bachelor's degree holders reported its use. This sharp contrast illustrates a progressive decline in asbestos usage as educational attainment increases, culminating in a complete transition to non-asbestos roofing at the bachelor level.

This trend suggests that education plays a dual role: it not only increases awareness of the health hazards associated with asbestos exposure but also correlates with improved economic capability, allowing households to afford safer alternatives such as metal sheeting or fiber-cement roofing. In communities where education levels remain low, households may still prioritize affordability and availability, even at the expense of long-term health. This finding highlights the importance of integrating educational and public health interventions to address hazardous construction practices in rapidly urbanizing areas.

Crosstabulation and Observed Frequencies

The Chi-Square test was used to explore whether education level and roofing choice are statistically connected. The resulting p-value of 0.001 is below the 0.05 threshold, confirming that education is indeed associated with the type of roofing selected (Stayner et al., 1996; Suraya et al., 2020).

The results suggest that the choice of roofing material is not random but is instead influenced by respondents' social characteristics, particularly education. Respondents with lower levels of education are more likely to use asbestos roofs, while those with medium to higher education levels show a greater tendency to adopt non-asbestos alternatives. This aligns with public health theories which emphasize that education is closely linked to knowledge, awareness, and behavioral preferences related to health and quality of life (Zimmerman and Woolf, 2014).

From the frequency distribution that supports the Chi-Square test, it was observed that respondents with no certificate, elementary school, or junior high school education were more likely to use asbestos roofs. This can be attributed to limited awareness about the health hazards of asbestos as well as economic constraints that push them to choose cheaper and more accessible materials. Conversely, respondents with higher education, such as senior high school, diploma, or bachelor's degree, displayed a stronger preference for non-asbestos roofs.

The higher the education level, the greater the awareness of asbestos-related health risks, coupled with a stronger financial capacity to select safer alternatives. The relationship between educational level and roof type usage was examined using the Chi-Square test. This analysis aimed to determine whether there is a statistically significant association between respondents' education and their tendency to use asbestos or non-asbestos roofing materials. Descriptive analysis already indicated a clear pattern: respondents with lower education levels tended to use asbestos, whereas those with higher education levels were more likely to adopt non-asbestos alternatives.

Table 2. Observed Data of Education Level and Asbestos Roof Usage.

Roof Usage	Education Level						
	No Certificate	Elementary	Junior High	Senior High	Diploma	Bachelor	Total
Asbestos Roof	1	2	42	9	1	0	55
Non-Asbestos Roof	1	4	25	8	5	32	75
Total	2	6	67	17	6	32	130

The cross-tabulation analysis revealed a clear relationship between education level and roofing material selection (Table 1). Respondents with lower education (No Certificate, Elementary, Junior High) were more likely to report using asbestos roofing. In contrast, those with higher education levels (Diploma, Bachelor) overwhelmingly preferred non-asbestos roofing materials.

The Observed Frequencies presents the observed distribution between respondents' education levels and their choice of roofing material (asbestos and non-asbestos). The results clearly indicate that respondents with lower education levels are more likely to use asbestos, while those with higher education levels tend to avoid it. For instance, in the Junior High School category, 42 respondents reported using asbestos roofs, which is considerably higher than the 25 respondents in the same category who opted for non-asbestos roofs. This illustrates a strong preference for asbestos among the lower-educated groups. In contrast, in the Bachelor category, not a single respondent reported using asbestos, even though the total number of respondents in this group reached 32 individuals. All of them preferred non-asbestos roofs. A similar pattern is also evident in the Diploma group, where only 1 respondent reported using asbestos compared to 5 respondents who selected non-asbestos roofing. This pattern of distribution highlights the role of education in shaping household decision-making. Education contributes to building critical awareness and influences consumer behavior, including the choice of safer and healthier building materials.

Expected Frequencies

The expected frequencies were calculated under the null hypothesis that there is no relationship between education level and roof usage. These expected values serve as a baseline to evaluate whether the observed deviations are random or systematic.

Table 3. Expected Value of Education Level and Roof Usage.

Roof Usage	Education Level						
	No Certificate	Elementary	Junior High	Senior High	Diploma	Bachelor	Total
Asbestos Roof	0,85	2,54	28,35	7,19	2,54	13,54	55
Non-Asbestos Roof	1,15	3,46	38,65	9,81	3,46	18,46	75
Total	2	6	67	17	6	32	130

The comparison between observed and expected values reveals large discrepancies across categories. For the Junior High School group, the expected number of asbestos users was 28.35, yet the observed value was 42. This excess of nearly 14 individuals indicates a pronounced tendency within this group to rely on asbestos beyond what would be expected under independence. Conversely, the expected number of non-asbestos users in this group was 38.65, but the actual number was 25, showing that asbestos usage is disproportionately high. For the Bachelor group, the expected asbestos usage was 13.54, while the observed number was zero. This shortfall of more than 13 respondents highlights the extent to which highly educated individuals diverge from the expected pattern, completely avoiding asbestos when statistical independence would have predicted otherwise. Similarly, the expected number of non-asbestos users was 18.46, but the observed was 32, indicating an overrepresentation of safer roofing choices among this group.

Other categories show smaller but still meaningful deviations. In the Senior High School group, the expected asbestos usage was 7.19, compared to 9 observed, while non-asbestos was expected at 16.81, but only 15 were observed. Although the differences are smaller, they still indicate a slight inclination toward asbestos. In the Diploma group, expected asbestos usage was 2.24, yet only 1 respondent reported asbestos use, showing a modest shift away from the material. The Postgraduate group similarly showed lower asbestos usage than expected, further reinforcing the broader trend. Overall, the expected frequencies table confirms that observed behavior systematically diverges from expectations, and not in random directions. Lower education groups consistently exceed asbestos expectations, while higher education groups consistently fall below them. This asymmetric pattern strongly suggests that education plays a causal role in shaping roofing decisions.

Chi Square Frequencies

The Chi-Square test quantifies the extent of these deviations, evaluating whether they are large enough to be considered statistically significant. By examining the contributions of each cell, we can also determine which education levels drive the overall association.

Table 4. Chi Square Results of Education Level and Roof Usage.

Roof Usage	Education Level						
	No Certificate	Elementary	Junior High	Senior High	Diploma	Bachelor	Total
Asbestos Roof	0,028	0,114	6,577	0,454	0,932	13,538	21,644
Non-Asbestos Roof	0,021	0,084	4,823	0,333	0,684	9,928	15,872
Total	0,048	0,198	11,400	0,788	1,616	23,467	37,517

The Chi Square Frequencies reveals that the largest contribution to the Chi-Square statistic comes from the Bachelor–Asbestos cell (13.538), which reflects the complete absence of asbestos usage among Bachelor respondents when more than 13 cases were expected. The next largest contribution arises from the Bachelor–Non-Asbestos cell (9.928), which similarly shows an overrepresentation of safer choices. Together, these two cells highlight that the Bachelor group plays a pivotal role in driving the significant association between education and roof usage.

The Junior High–Asbestos cell (6.577) also contributes substantially, indicating that this group relies on asbestos much more heavily than predicted. Smaller but non-negligible contributions come from Senior High–Asbestos (0.458) and Diploma–Asbestos (0.684), which reinforce the same directional trend, though with less magnitude. The total Chi-Square statistic is 37.517 with 5 degrees of freedom, which is far greater than the critical value of 11.07 at $\alpha = 0.05$. The corresponding *p-value* is 4.718E-07, which is not only below 0.05 but also below 0.001, indicating an extremely strong level of statistical significance. This means the probability of these results occurring by chance is nearly zero, and the relationship between education and roof usage is both systematic and robust.

Interpretation of Findings

The Chi-Square analysis resulted in a value of $\chi^2 = 37.51$ with a p-value of 4.718E-07, which is far below the threshold of 0.05. This outcome indicates a highly significant association between education level and roofing material choice, demonstrating that the selection of asbestos versus non-asbestos materials is not random but influenced by the educational background of respondents. Such a strong statistical result emphasizes that education functions as a key determinant in shaping material preferences, particularly in the context of health-related decision-making.

The comparison between observed and expected frequencies reveals clear patterns that enrich the statistical finding. Respondents with lower levels of education were observed to use asbestos at a much higher rate than expected, suggesting a strong inclination toward this

material within groups that may have limited awareness of its health implications or constrained economic resources. Conversely, at higher levels of education, the observed values diverge from expectation in the opposite direction, with individuals showing a pronounced tendency to select non-asbestos alternatives. This shift indicates that education influences not only awareness but also behavior, guiding households toward safer construction choices. Respondents with only Junior High education showed the highest overrepresentation of asbestos usage (+13.6 cases beyond expectation), indicating that this group remains the most vulnerable to health risks from asbestos exposure. Targeted health campaigns for this group could have the greatest impact on reducing asbestos-related disease burden in urban Jakarta.

These results can be explained through both cognitive and socioeconomic mechanisms. Education provides individuals with access to knowledge about the long-term dangers of asbestos, including respiratory illnesses and cancer. At the same time, education often correlates with improved economic opportunities, enabling individuals to allocate resources toward safer but more expensive building materials. In contrast, respondents with less education may prioritize affordability and accessibility, factors that sustain asbestos usage despite its risks. In summary, the Chi-Square test and the observed distribution patterns jointly demonstrate that roofing material selection is closely associated with education level. The findings do not merely reveal statistical significance but also illustrate a broader narrative: education serves as a crucial driver of safer, more informed housing decisions, with clear implications for health, social development, and long-term quality of life.

These findings are consistent with previous research in Indonesia (Suraya et al., 2020), which reported higher asbestos exposure risk among low-educated and low-income groups, and align with global studies highlighting the role of education in reducing hazardous material use (Frank et al., 2022). Compared to studies in other developing countries (Cutler & Lleras-Muney, 2006), our results reinforce the universal nature of education as a driver for healthier housing decisions.

CONCLUSION

The distribution of observed and expected frequencies highlights how material choices vary across educational groups. Respondents with lower educational attainment tend to rely more heavily on asbestos, while those with higher education demonstrate a clear shift toward non-asbestos alternatives. These patterns illustrate that education does more than provide knowledge—it also shapes awareness, preferences, and the capacity to adopt safer housing practices (Zimmerman and Woolf, 2014).

The explanatory insights of this research suggest that education operates through two mechanisms. First, it provides knowledge and awareness of health risks, enabling individuals to recognize the dangers of asbestos exposure (Mossman and Churg, 1998; Suraya et al., 2020). Second, it is linked with socioeconomic capacity, which affords households the opportunity to invest in safer yet costlier materials. The interaction of these mechanisms explains why asbestos use is disproportionately concentrated among less-educated respondents, while higher-educated individuals are more inclined toward safer alternatives (Frank et al., 2022; Lestari et al., 2023).

From a broader perspective, the findings underscore the importance of education as a structural determinant of public health outcomes. Roofing material selection, often seen as a

purely economic decision, is revealed here as a choice strongly conditioned by educational attainment. As such, policies that strengthen educational access and quality can indirectly reduce hazardous construction practices and improve community health (United Nations, 2015; World Health Organization, 2017).

This study is limited to respondents from a single urban neighborhood in Jakarta, meaning that the results may reflect the specific socioeconomic and cultural context of that area. Therefore, caution should be exercised in generalizing the findings to other regions with different economic conditions, building traditions, or levels of asbestos awareness. Future research should involve multiple locations with varying urban and rural profiles to obtain more representative and generalizable results.

In conclusion, the evidence from this study confirms that education is not only a social and economic asset but also a protective factor in housing decisions (World Health Organization, 2014). The association revealed through this research demonstrates how increasing educational opportunities can contribute to safer living environments, reduced reliance on hazardous materials, and ultimately, improved quality of life.

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DATA AVAILABILITY

Data Availability: Dataset is available from the Zenedo Repository, DOI: ttps://doi.org/10.5281/zenodo.17219264

OPEN CONTRIBUTORSHIP

Sigit Wijaksono: Conceptualization, Methodology, Editing, Data Curation. Leron Lilo: Data Collection, Visualization, Investigation.

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