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Use of geological maps in detecting asbestos-related diseases; A new region in Anatolia

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We adhered to the Strengthening the Reporting of Observational Studies in Epidemiology guidelines (EQUATOR Network reporting guidelines).

Author contributions

All authors contributed to the study conception and design. Data collection and analysis were performed by Mehmet Bayram, Material preparation and were performed by Abdullah Kansu, Mehmet Bayram, Zeynep Eğri Kansu and Hamza Ogun. Manuscript was written by Hamza Ogun and Mehmet Bayram. All authors read and approved the final manuscript.

Data availability

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

Ethical Considerations & Disclosure

This study was approved by the local medical ethical board at Bezmialem Vakif University. (# 2017-12/179). This study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Clinical Signifcance

New settlements with environmental asbestos-related disorders are currently being identified in Turkey and around the world. Our research confirms the usefulness of geological maps in identifying residential areas at risk of NOA, offering valuable and noteworthy findings.

ABSTRACT

Objective: To examine the potential relationship between the presence of asbestos-related diseases (ARDs) in the region of Kastamonu, Turkey.

Methods: The birthplaces of patients with ARDs and control subjects diagnosed between 2008 and 2019 and identified in a tertiary hospital in Istanbul. Soil samples were taken from plaster surfaces and quarries. The analysis was done with transmission electron microscopy.

Results: Of 307 participants, 55 (17,9%) with ARDs . Patients had a mean age of 68±11 years. Residential proximity to ophiolites increased ARD incidence by 6.2% per km ($p=0.003$). Birthplaces were identified as being inside an ophiolitic unit, or if they weren't, the Google Earth software was used to determine the beeline distance between the settlement's center and the edge of the closest ophiolitic unit. The appropriate threshold for this case is 12.75 kilometers, with 75% sensitivity and 87% specificity.

Conclusion: ARDs due to naturally occurring asbestos (NOA) are present in hitherto unknown places. Geological maps including ophiolites can help locate these places.

Keywords

Naturally occurring asbestos, asbestos-related diseases, mesothelioma, ophiolites

Learning Outcomes

This study aims to achieve the following three objectives;

-Raising awareness about environmental asbestos-related diseases.

-Detection of naturally occurring asbestos with geological maps and examining its clinical reflection.

-To develop questioning about the relationship between environmental asbestos and the places where patients live.

INTRODUCTION

The overall term for magnesium silicates is asbestos, which encompasses six forms of fibrous silicates, namely serpentine and amphibole subtypes. Over the course of nearly a century, this material has found widespread application across several industries owing to its exceptional ability to withstand high levels of stress, resisting breakdown from heat and chemical exposures. The utilization of asbestos was prohibited subsequent to the establishment of its causal relationship with mesothelioma.

In addition to the presence of industrial asbestos, there are asbestos-related disorders (ARD) that are linked to naturally occurring asbestos (NOA) found in specific geographical regions. NOA related disorders have been documented in various Mediterranean nations, including Turkey[1], Greece[2], Cyprus[3], Italy[4], Corsica[5], and the United States[6]. Additionally, cases have been reported in China[7] and New Caledonia [8]. In addition, erionite, a fibrous mineral, has been identified as a causative agent of mesothelioma in three villages located in the Cappadocia region of Turkey[9].

Despite the prohibition of industrial asbestos usage and the anticipated decline in the occurrence of associated illnesses, the issue of environmental asbestos exposure remains a matter that necessitates consideration.

While there exists a considerable degree of awareness of environmental asbestos exposure in specific areas of Turkey and globally, it is crucial to acknowledge the potential for asbestos exposure and associated diseases to arise among communities residing near NOA structures that have not yet been documented or identified.

Ophiolithic rocks are geological formations that arise as a result of tectonic activities in the upper mantle. They manifest on the Earth's surface in specific places. These formations hold significant relevance as suppliers of NOA[10,11] and primarily consist of chrysotile, with a lesser quantity of tremolite. Asbestos exposure can occur as a result of the discharge of asbestos fibers from structures owing to meteorological circumstances, as well as the utilization of soils sourced from ophioltic units in the whitewashing and plastering processes, including human intervention.

Anatolia exhibits high abundance of ophiolitic units as a result of its geological formation[12]. Consequently, several regions exhibit the presence of disorders linked to environmental asbestos exposure. As a consequence of enduring public awareness, preventive health measures are currently being adopted in these regions. Nevertheless, it is plausible that there exist geological locations harboring asbestos that have not been thoroughly examined in the scientific literature. The identification of these regions is of utmost importance for the implementation of preventive health initiatives and the promotion of disease awareness.

We recently recently conducted a research in a tertiary hospital in Turkey to examine the occupational exposure ratio of naturally occurring asbestos for diseases related to asbestos[13]. In the conducted study, it was observed that individuals who had been exposed to naturally occurring asbestos were predominantly from the north central Anatolia region, more especially the province of Kastamonu. It is noteworthy that cases of asbestos-related diseases (ARDs) had not been previously documented in this particular area.

The objective of this study is to examine the incidence and extent of ARDs within a particular region. This will be accomplished by analyzing hospital records of individuals born in

Kastamonu, assessing the proximity of their birthplaces to asbestos-containing geological formations, and evaluating the presence of asbestos in household plaster and the quarries from which the plaster soil is sourced.

METHODS

Patient Selection

Previous research has provided thorough details on how to choose cases and controls, define the methodology for evaluating asbestos exposure, and determine the probability of asbestos exposure at work[13]. In summary, our dataset had 307 cases and 307 age and gender matched control patients after removing people for whom radiological, demographic, and occupational data were not accessible. Those whose birthplace was outside of Kastamonu province were deliberately taken off of the patient and control lists.

Determining the type of asbestos exposure

The birthplaces of the patients were located on a map of Kastamonu province, and the location of the settlement was determined with respect to ophiolites as determined from the geological map of Turkey's General Directorate of Mineral Research and Exploration[14]. Figure 1 illustrates the location of ophiolites subsequent to the exclusion of all other geological formations from the original map. Additionally, it shows the birthplaces of both case and control patients. Birthplaces were identified as being inside an ophiolitic unit, or if they weren't, the Google Earth software was used to determine the beeline distance between the settlement's center and the edge of the closest ophiolitic unit. A settlement is considered to be close to environmental asbestos exposure if it is located within a radius of less than 10 km based on to previous studies[8,15]. We categorized asbestos exposure at work using the proportionate mortality ratios (PMR) for asbestosis that NIOSH published[16]. High-risk occupations were those with PMR >3, medium-risk occupations were those with PMR 1-3, and lowest-risk occupations were those with PMR less than 1 and all occupations without an asbestos source. Based on a combination of the likelihood of asbestos exposure at work and the distance from a ophiolitic unit, we created categories for asbestos exposure[13].

Analyzing soil sample

House plaster and soil quarry samples were collected from the three villages with the highest ARDs rate among all villages.These samples were analyzed by scanning electrone microscopy. The imaging technique employed in this study was the use of scanning electron microscopy (SEM) on an FEI Quanta 200 device. The instrument was equipped with a field emission gun (FEG) and an energy-dispersive spectrometer (EDS). To discern asbestos fibers from a chemical perspective, a three-point analysis was performed on each individual fiber.

Statistical analysis

The Mann-Whitney U test was employed to conduct a comparison of continuous variables. The analysis of categorical variables was conducted using chi-squared tests. Binary logistic regression analysis was used to calculate the risks of ARDs with increasing proximity of the birthplace to NOA ophiolitic units, as compared with control group. Receiver-operating characteristic (ROC) curves were utilized in order to evaluate the discriminatory capacity of the distance between the subjects' birth location and the nearest ophiolitic unit. This assessment aimed to determine the sensitivity and specificity of several cut-off values in distinguishing between cases and the control group. Statistical significance was determined by considering results to be significant if the two-tailed P values were less than 0.05. The analyses were conducted utilizing the SPSS software (version 14.0). This study was approved by the local medical ethical board. (# 2017-12/179).

This study was designed in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines (Supplemental Digital Content, http://links.lww.com/JOM/B632)[17].

RESULTS

The integrated flowchart including the results of the previous and current studies is shown in Figure 2. Out of the total sample size of 307 patients in the case group, 55 individuals (17,9%) were born in Kastamonu. Similarly, among the 307 control patients, 12 individuals (3,9%) were also born in Kastamonu. Pleural plaque in 47 patients (85,5%), pleural plaque accompanied by bronchial carcinoma in 3 patients (5,5%), diffuse pleural thickening in two patients (3.6%), asbestosis in 2 patient (3,6%) and mesothelioma in 1 patient (1.8%) were identified. Patients had a mean age of 68±11 years. Table 1 displays a comparison of demographic, residential, occupational information, and exposure type as well as the distance from the birthplace to the nearest NOA. The participants were classified based on their exposure to asbestos. It was found that 69% of the cases had only been exposed to asbestos in the environment, while 9% had only been exposed to asbestos in their occupation. In comparison, the control group had exposure rates of 25% and 8% for environmental and occupational exposure, respectively (p=0.001).

The Odds ratio decreased by 0.938 for each additional kilometer distance from source, with a %95 confidence interval of 0.89-0.98 (p=0.003). For the distance between birthplace and nearest ophiolitic unit, the ROC area under curve was 0.82 (p<0.001). The optimal distance between the place of birth and the closest NOA was 12.75 kilometers. This threshold distinguished patients with ARDs from controls with 75% sensitivity and 87% specificity.

Samples were collected from soil quarries in the three villages with the highest prevalence of ARDs, as well as from the wall plaster of the home of a patient diagnosed with pleural calcification. Examination by electrone microscopy confirmed the presence of chrysotile asbestos in three of these samples, as well as the presence of tremolite asbestos in one sample (Table 2). Figure 3 shows a satellite image of a village near the ophiolitic units, as well as a scanning electrone microscopy and energy-dispersive spectrometer image of a plaster sample taken from the home of an ARDs patient born in this village.

DISCUSSION

This investigation unveiled the presence of individuals diagnosed with ARDs due to exposure to NOA in the rural regions of Kastamonu, located in the northern central Anatolia. This study represents the first investigation highlighting the occurrence of diseases associated with naturally occurring asbestos exposure within this particular geographic area.

The study revealed a statistically significant association between asbestos exposure in the environment and the proximity of villages to ophiolitic units, which are known to be substantial sources of naturally occurring asbestos (NOA). According to a cross-sectional study conducted by Döngel et al.[18], residing in close proximity to ophiolitic units in Sivas, a central Anatolia Province, is identified as a risk factor for ARD. In a similar vein, Pan et al. have provided evidence indicating that residing in close proximity to asbestos deposits in California constitutes a significant risk factor for the development of mesothelioma[6]. The findings of this study indicate that there was a decrease of 6.3% in the occurrence of ARDs for every additional kilometer of distance from the NOA. A retrospective study from California revealed a 6.3% decrease in mesothelioma risk for every 10 km distance to NOA[6]. In the assessment of the tribes residing in New Caledonia, it was observed that the odds ratio for mesothelioma was 7.7 times higher among tribes located within a proximity of 10 km from the asbestos-containing massif, compared to tribes situated at a distance exceeding 10 km. In a similar vein, the odds ratio for Mesothelioma was seen to be 9.4 and 2.5 times higher among tribes residing within a distance of up to 3 km and between 3-9 km from the soil quarry, respectively, compared to tribes situated at a distance exceeding 9 km[8]. In the study conducted by Bayram and colleagues, in an area where industrial asbestos exposure was absent, approximately 80% of ARDs patients resided within 10 kilometers of the ophiolitic belts[15].

Soil is traditionally used to plaster the walls of homes in rural areas of Anatolia. The peasants who live near ophiolitic units in particular like to use to use white soils (white soil is *corak* in the local dialect) that taken from these areas,. They typically don't know that it includes asbestos, but they do believe that this particular type of soil has qualities related to thermal insulation. On the other hand, farms, dirt roads, and settlements located inside ophiolitic units can also expose people to asbestos. While we were unable to distinguish between indoor and outdoor exposure in this study, our goal was to find out the risk of ARDs at undefined rural area close to NOA source.

Studies examining the etiology of asbestos-related diseases typically include an assessment of mesothelioma, focusing on its association with occupational or environmental factors. Due to its accessibility through hospitals and cancer registries, it is more convenient to obtain information. Nevertheless, given the relatively low incidence of mesothelioma, it may be inadequate to identify high-risk occupations and residential regions in relation to asbestos exposure. However, because bilateral pleural plaques, which usually do not have clinical symptoms on their own, are seen at a higher rate in people exposed to asbestos than mesothelioma, they are used as indicators in screening for both occupational and environmental fibrous mineral exposure[19]. The prevalence of mesothelioma was found to be 300 times higher in a village in Northern Greece where the subjects with pleural plaques had previously been characterized[2]. In the 2012 study conducted in Büyüktatlar village of Kahramanmaraş province, it was observed that 11.5% of the patients had chest X-ray findings indicative of pleural calcifications[20]. In a comprehensive investigation involving the systematic examination of chest X-rays among a population of around 7000 individuals residing in the vicinity of Cermik, located in the south-eastern region of Turkey, the presence of pleural thickening and calcifications was shown in 6.5% of the subjects[21]. Including patients with pleural plaques (%88 of the case group) allowed us to detect ARDs in this study. Given the current circumstances, it may be more suitable to add bilateral calcified pleural plaques to assist in detecting hazardous occupational and environmental risks connected with asbestos exposure. Pleural plaques are commonly connected with asbestos exposure, but it is important to note that exposure to other compounds can also result in the development of pleural plaques[22,23].

However, it is commonly recognized that thorax CT scans demonstrate higher levels of sensitivity and specificity in the assessment of ARDs when compared to lung radiography[24,25]. The evaluation of asbestos-related diseases in all participants was performed using thoracic computed tomography images.

Cross-sectional or retrospective studies based on health records to screen for the presence of NOA-related asbestos-related diseases in certain regions may not accurately detect areas of disease risk. For example the detection of an asbestos-related disease in two out of three settlements within the same area, is more plausibly attributed to the limited incidence of the disease rather than a lack of asbestos exposure in the third settlement at the time of assessment. The Turkish mesothelioma surveillance study examined the cases of mesothelioma diagnosed in Turkey between 2008 and 2012[26]. The study identified a total of 158,068 individuals residing in 379 villages who were deemed to be at risk of asbestos exposure. Specifically, there were a total of 28 villages located within the boundaries of Sivas province. In contrast, a controlled study conducted in Sivas revealed the presence ARDs in 125 separate villages, while mesothelioma cases were identified in 59 separate villages during the period of 2000 to 2010[15]. The disparity in the number of villages classified as risky for asbestos exposure in a given geographic region, as observed in studies conducted over two comparable time periods, supports the inclusion of regional-scale NOA protection measures alongside patient record-based investigations.

The research was carried out at a tertiary hospital located in Istanbul. Hence, a significant proportion of these patients resided in Istanbul. According to statistics provided by Türkiye Statistical Institute, Istanbul is home to a significant population originating from Kastamonu, which constitutes the second largest demographic group in the city, accounting for approximately 3.5% of the total resident[27]. The incidence of registration in Kastamonu province was 17% among patients in the case group, whereas the control group had a comparable rate of 3.9%. Industrial asbestos exposure is a significant confounding factor among patients residing in Istanbul. In order to address this potential source of bias, we collected the lifetime work history of all participants and identified the jobs with the greatest asbestos-related PMR. Nine of the patients diagnosed with ARDs were found to have employment classified in the high category of PMR. It is noteworthy that work exposure was recognized as the sole cause of exposure in five of these instances, whereas the remaining four patients reported both occupational exposure and close proximity to environmental asbestos.

The main limitation of our study is the retrospective design of the study. The patients themselves or their relatives were contacted by phone. Their lifelong occupational history and the places they lived were determined. However, occupational risk classification based only on verbal declaration, not based on official records, may have caused recall bias. The majority of females were categorized as housewives. Indeed, it is established that all women residing in rural areas were engaged in agricultural activities, albeit their contributions were not documented.

One notable limitation of our study pertains to the inability to ascertain the duration of exposure and subsequent cumulative fiber exposure. This restriction arises from our only relying on the location of birth and verbal occupation declaration as a proxy for exposure, as we were unable to reconstruct the complete residence or work history of the participants. Nevertheless, the robust association between place of birth and risk implies that it served as a reliable proxy for cumulative exposure over one's lifetime and/or underscores the significance of early-life exposure to naturally occurring asbestos in determining the likelihood of developing subsequent health conditions. The utilization of birthplace was deemed suitable due to its consideration of the extended period between illness occurrence and exposure. Additionally, this approach effectively circumvented the potential misclassification of exposure resulting from the significant rural-to-urban migration observed in Turkey during recent decades. The matter at hand holds significant relevance within the context of the region under examination. Based on the 1985 census data, the overall population of Kastamonu province was recorded as 450,353 individuals, with 328,003 residing in rural areas. However, by 2022, the total population had declined to 378,115, indicating a decrease of 16%. Notably, the rural population experienced a more significant decline, reaching 134,115 individuals, which represents a decrease of 59%. These figures suggest a substantial migration trend towards urban centers. Although some of our patients (cases or controls) may have migrated from non-ophiolite (urban or rural) areas to rural ophiolite locations, such migration, if any, is unlikely to have altered our results. Because there are no mines or asbestos-handling enterprises (such as shipyards or asbestos-cement manufacturers) in the province, significant exposure to commercial asbestos is highly unlikely, yet exposure to certain asbestos-containing products cannot be completely ruled out in some subjects.

This study is the initial investigation into the presence of environmental asbestos within the Kastamonu region. Our research provides new and valuable insights, including the utilization of geological maps for the identification of residential areas that are susceptible to NOA exposure. This issue is not only of regional concern, but also has global implications for public health.

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Figure Legends

Figure 1: The distribution of ophiolitic units, which reflect naturally occurring asbestos, as well as the locations of case and control patients in Kastamonu region. Adaptation from https://www.mta.gov.tr/v3.0/sayfalar/hizmetler/images/1000000_Jeoloji.jpg[14]

Figure 2: Flow Chart of the study.

Figure 3: The Upper part; Satellite image of a village near the ophiolitic units. Ophiolitic units can be seen in the gray areas within the red ellipse in the satellite image. The bottom of the image shows a scanning electrone microscopy and energy-dispersive spectrometer image of a plaster sample from the house of a patient with ARDs who was born in this village.

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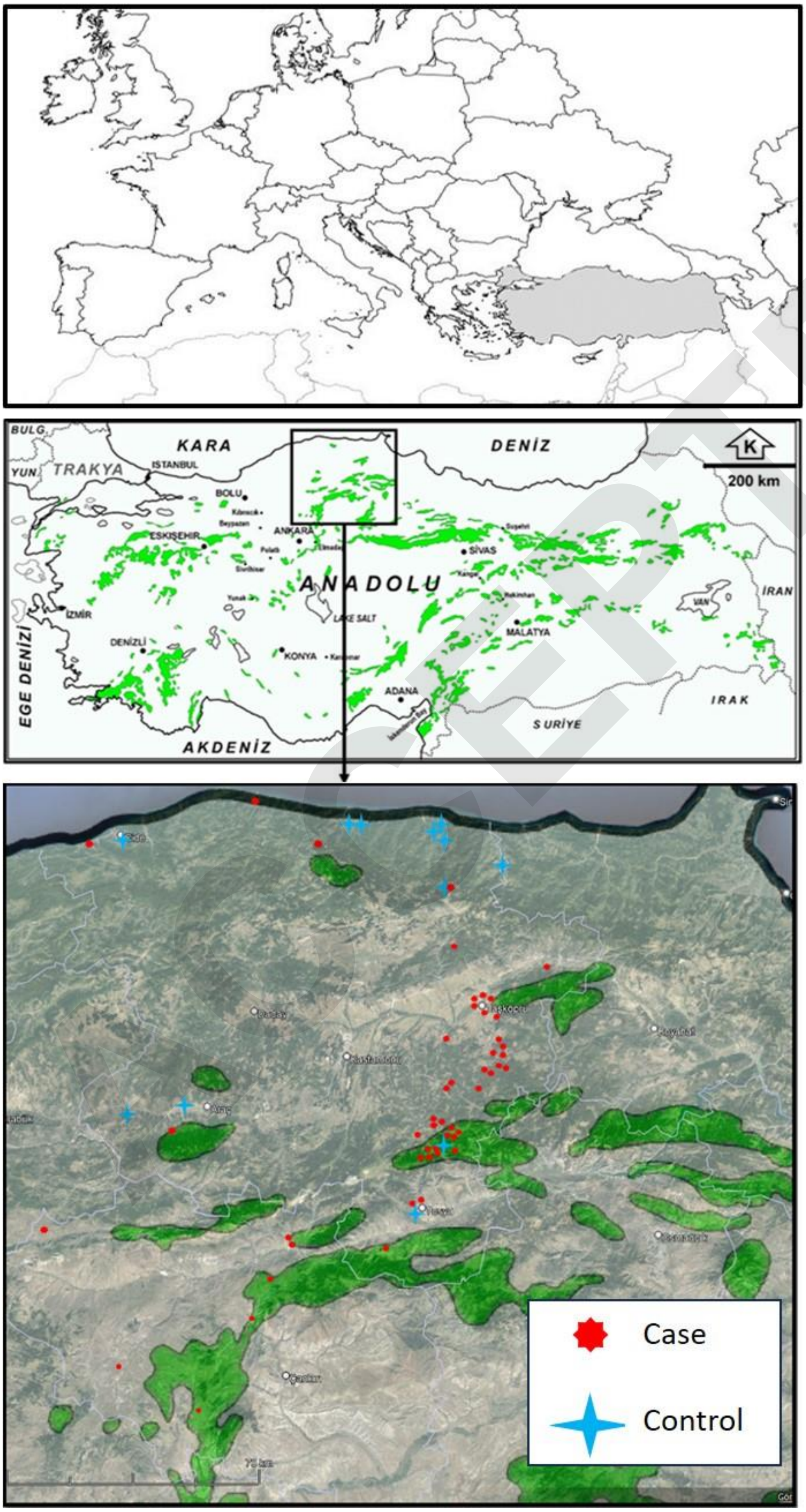

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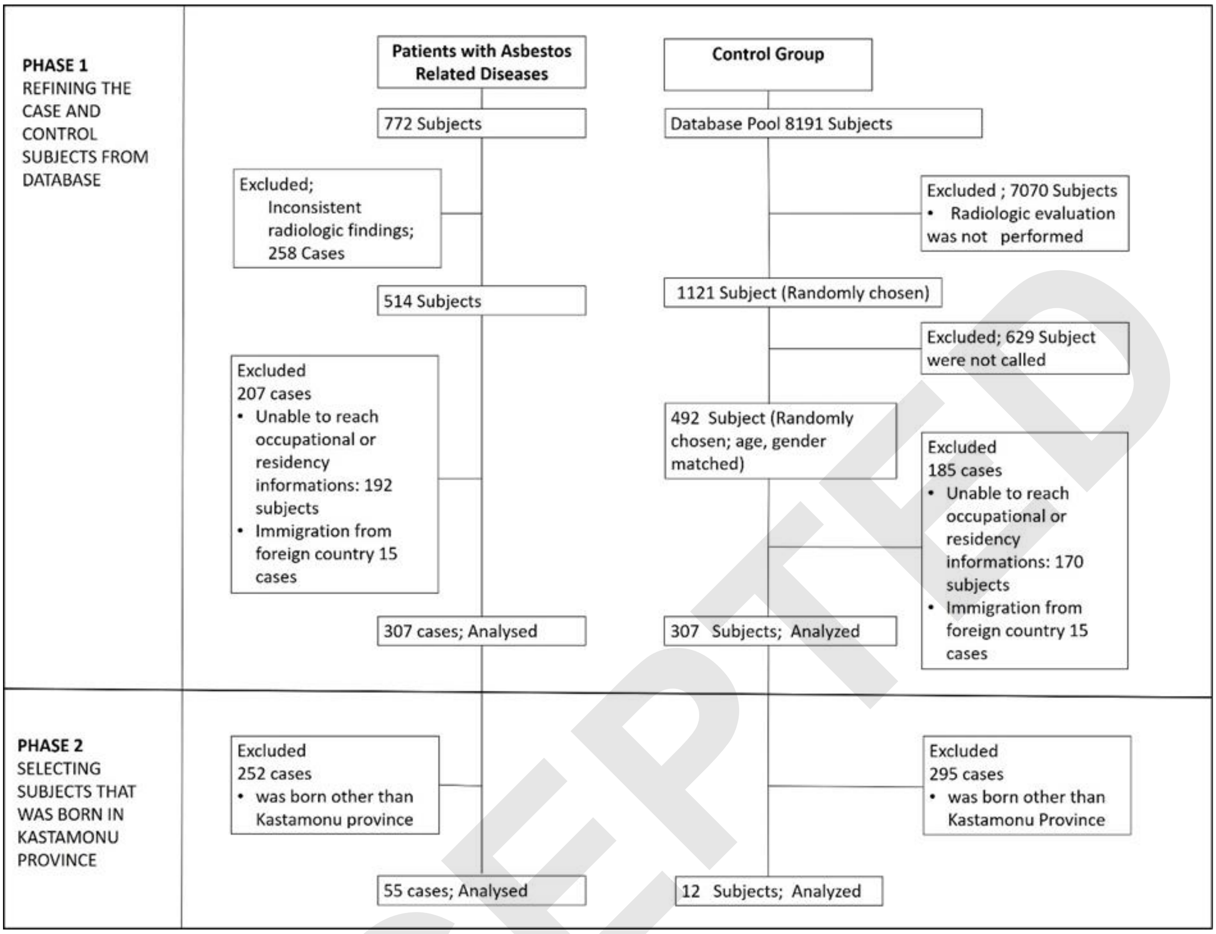

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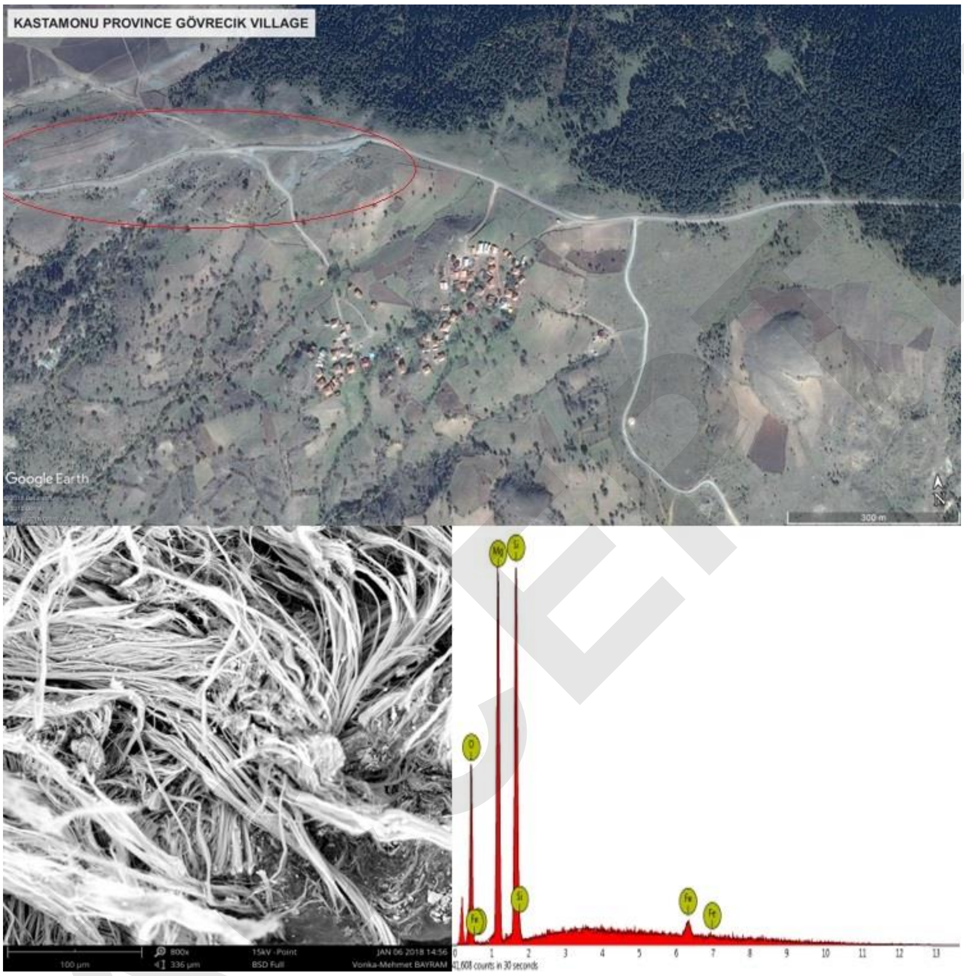


Table 1: Comprehensive comparison of demographic, residential, and occupational information, as well as the distance from the birthplace to the nearest Naturally Occuring Asbestos

		Case n=55	Control n=12	p
Gender n, (%)	Male	38 %69,1	9 %75	N.S.
	Female	17 %30,9	3 %25	
Age, Median Range (min-max)		69 (43-89)	71,5 (50-83)	N.S.
Risk of occupational exposure n, (%)	High	9 (16,4)	1(8,3)	N.S.
	Moderate	4 (7,2)	2 (16,7)	
	Low	42(76,4)	9(75)	
Exposure Type n, (%)	Environmental Only	38 (69,1)	3 (25)	0.001
	Occupational Only	5 (9,1)	1 (8)	
	No Exposure was found	5 (9,1)	7 (58)	
	Environmental and Occupational together	7 (12,7)	1 (8)	
Distance of residency to NOA* n, (%)	Close	43 (78,2)	3 (25)	0.001
	Far	12 (21,8)	9 (75)	
The distance of birth place to nearest NOA (km) Median Range (P25-P75)		2 (0-10)	26 (7,5-34,5)	<0.001

Data are presented as number and percentage or median and 25th ve75th percentile where available.
Abbrevations: N.S.: Not Significant, NOA: Naturally occurring asbestos

**Based on previous studies, the accepted cutoff value for distance is 10 kilometers.*

Table 2: Collection of house plaster, soil, and earth quarry samples from three villages with a high prevalence of Asbestos Related Diseases patients.

District	Coordinates	Source	Fibrous mineral
Taşköprü	41°12’10.23” N 34°08’17.1” E	Soil quarry	Chrysotile
Tosya	41°08’43.72” N 34°06’31.82” E	Plaster	Tremolite
Taşköprü	41°11’23.14” N 34°08’32.57” E	Soil quarry	Chrysotile
Tosya	41°09’16.23” N 34°06’13.55” E	Soil quarry	Chrysotile

STROBE Statement—Checklist of items that should be included in reports of ***case-control studies***

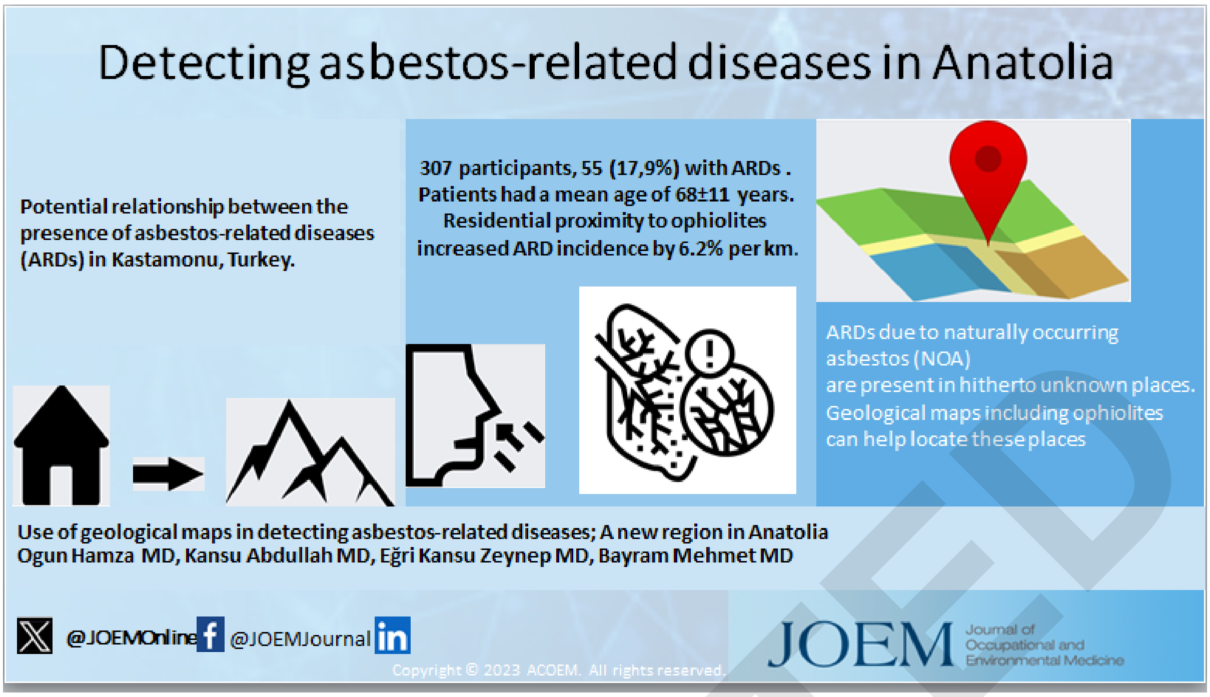
	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	2
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls	2,3
		(*b*) For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	3
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	3
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4
		(*b*) Describe any methods used to examine subgroups and	4

		interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, explain how matching of cases and controls was addressed	
		(*e*) Describe any sensitivity analyses	4
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	4
		(b) Give reasons for non-participation at each stage	4
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	4
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers in each exposure category, or summary measures of exposure	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	4
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	4
Discussion			
Key results	18	Summarise key results with reference to study objectives	5
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	5-7

Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	6,7
Generalisability	21	Discuss the generalisability (external validity) of the study results	7
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	

*Give information separately for cases and controls.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.


Detecting asbestos-related diseases in Anatolia
Potential relationship between the presence of asbestos-related diseases (ARDs) in Kastamonu, Turkey.
307 participants, 55 (17,9%) with ARDs . Patients had a mean age of 68±11 years. Residential proximity to ophiolites increased ARD incidence by 6.2% per km.
ARDs due to naturally occurring asbestos (NOA) are present in hitherto unknown places. Geological maps including ophiolites can help locate these places
Use of geological maps in detecting asbestos-related diseases; A new region in Anatolia
Ogun Hamza MD, Kansu Abdullah MD, Eğri Kansu Zeynep MD, Bayram Mehmet MD
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