Environmental pulmonary health problems related to mineral dusts: Examples from central Anatolia, Turkey
M. Doğan

Abstract There are a number of benign disorders including pleural thickening (PT), calcified pleural plaques (CPP), and malignant diseases such as malignant pleural mesothelioma (MPM) in central Anatolia. Earlier studies suggested tremolite was the main cause, and there was no explanation why some of the population did not have malignant cases, and plaques were by far the most frequent manifestation of asbestos-induced injury. In this study, geological, mineralogical and environmental data were evaluated. While the prolonged continuous exposure to high or low doses of long (8–30 μm) and thin (less than 0.25 μm) mixed fibers such as chrysotile, and/or anthophyllite or tremolite, and also silica particles may be the cause of MPM in central Anatolia, two different reasons for the CPP and PT are suggested. The first one is short (less than 8 μm) and thin mixed-type mineral fibers. The second reason is low doses of long, but thick, splinterly tremolite fibers.

Keywords Central Anatolia · Mineral dust · Pulmonary diseasesz

Introduction

Despite the extensive cancer studies in humans, many scientific and medical questions still remain unanswered, and certain controversies remain about fiber-exposure pathogenesis of pulmonary problems. The question of carcinogenic potential and other types of pulmonary diseases, such as calcified pleural plaques and pleural thickening caused by these minerals, is not only of scientific interest, but also has economic, legal, public policy, and public health importance.

Epidemiological studies indicate that high frequency of malignant pleural mesothelioma (MPM), calcified pleural plaques (CPP), and pleural thickening (PT) constitute important pulmonary health problems in rural Turkey (Yazıcıoğlu and others 1980; Barış 1987; Barış and others 1988; Keyf and others 1994; Çöplü and others 1996; Karakoç and others 1997) and other Mediterranean countries, including Cyprus (McConnochie and others 1987), Greece (Constantopoulos and others 1985), and Corsica (Boutin and others 1986; Rey and others 1993). Olu and others (2000) studied the association of human herpes virus 8 (HHV-8) in central and southeastern Turkey which showed that HHV-8 DNA was absent in the mesothelioma patients. Emri and others (2000) also tested 29 mesothelioma patients from Turkey for simian virus (SV) 40. All 29 tissue specimens from the patients did not contain SV 40 DNA, but all of the patients were previously exposed to asbestos or erionite fibers. The data may imply mineral fibers such as asbestos and erionite remain the only known causal factors of mesothelioma in Turkey. All the previous studies were done by the medical community and reported that tremolite is the cause for MPM, CPP, and PT, but we lack lung burden studies in central Anatolia. Key questions remain. If tremolite fiber is the only cause, why are there CPP and PT cases, but no MPM observed in some locations? Why are CPP and PT ratios low in some other places? Is the primary controversy a question of fiber type, duration, size, or dose in the cause of mesothelioma? Are there cofactors? Doğan and Emri (2000) reported the environmental effects of fibers in parts of rural areas of Ankara and Eskişehir, and these questions were also left unanswered. In this study, a broader assessment was undertaken to obtain some answers. Geological and mineralogical investigations were combined with environmental evaluation of the initiation and cause of these pulmonary diseases in central Anatolia (includes the rural parts of Kastamonu, Ankara, Çankiri, Eskişehir, Kütahya, and Konya; Fig. 1).

Materials and methods

For practical reasons, locations are divided into two areas.
1. MPM locations: in the MPM locations, MPM cases and also CPP and PT are present. Included are rural areas of Çankiri (Sabanözü, Gümerdüğin, Gürpinar, and Çapar) and Kiliçlar of Ankara, as well as rural parts of Eskişehir, Kütahya and Konya.

2. No-PMIP locations: only CPP and PT cases are present. No-PMIP locations include Edige near Ankara and Ilgaz near Kastamonu.

Although PT and CPP incidences are very high at both locations, i.e., 42.3% of the population in Edige, and 18% of the population in Kureysler near Kütahya, comparing the two locations, CPP and PT incidences are lower in the rural areas of the MPM locations. Table 1 shows the number of MPM, CPP and PT cases reported from these locations. Since the statistical studies are not complete, death rates of MPM are higher than reported. In general, CPP and PT are common in both males and females. However, they are more common among the male population owing to smoking (Barış 1987).

Field reconnaissance and mineralogical studies were conducted to provide information to evaluate environmental impacts of the mineral dust. Ultramafic and mafic rocks are used by the villagers as garden walls, bricks, and natural insulation material for housing, such as white stucco plastered on walls, to filter grape molasses, and as baby powder. Although closed down in 1981, there are numerous abandoned asbestos mines (chrysotile) within 1–2 km from the villages of Sabanözü (Çankiri), and Mihalliçik (Eskişehir). Therefore, the people living in the MPM locations have been exposed to fibrous minerals since their birth.

Samples were collected from ultramafic and mafic rocks, soil, insulation materials, wall plasters, other materials used, and air samples in the residential areas. Fiber types were determined to find the link between mineral dust and potential sources of diseases. A total of 80 samples of source rocks, three samples from each material used (soil, insulation material and white stucco), and air samples for the residential areas were collected. Fibers were analyzed utilizing optical, scanning electron (SEM) and transmission electron microscopes (TEM), X-ray diffraction (XRD), and energy dispersive spectroscopy (EDS). SEM studies were performed using a S-4000 with field emission with 3–15 kV, and TEM studies were performed using a Hitachi H-100 TEM with 100 kV at the University of Iowa, USA. The XRD analyses were conducted using a Philips PW 1140 at the Hacettepe University, Ankara, and a Rigaku Gaiger Flex at the General Directorate of Mineral Research and Exploration (MTA), and Turkish National Petroleum Company (TPAO) laboratories. Water samples from the Ilgaz area were analyzed for particles. Human tissue and air-filter analyses from the literature were also taken into account.

### Distributions of hazardous minerals

The study area is within the ophiolitic belt of the Ankara Melange and Kütahya-Bolkar Zone which are remnants of the Tethyan ocean basins. They possess a tectonic mixture of ophiolitic material and sediments of oceanic origin with

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**Table 1**

<table>
<thead>
<tr>
<th>Type of cases reported</th>
<th>MPM locations</th>
<th>No-PMIP locations</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Çankiri</td>
<td>Kiliçlar (Elmadağ)</td>
</tr>
<tr>
<td>MPM</td>
<td>13 deaths</td>
<td>Two cases reported</td>
</tr>
<tr>
<td>CPP+PT</td>
<td>3+310</td>
<td>6 deaths</td>
</tr>
</tbody>
</table>

1994, Karakoca and others 1997; Kureysler (Kütahya): Çöplü and others 1996. MPM cases also reported from Kiliçlar of Elmadağ (Ankara) and Konya (Akay and Emri 2001, personal communication)