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Assessment of asbestos exposure during a simulated agricultural activity in the proximity of the former asbestos mine of Balangero, Italy

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HIGHLIGHTS

- We measured waterborne asbestos fibers in an asbestos-rich rural area.
- We simulated agricultural activity on a soil irrigated with asbestos-polluted water.
- The exposure of a worker during simulated tillage was measured, in two trials.
- The environmental dispersion of fibers outside the field was negligible.

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ABSTRACT

The natural occurrence of asbestos (NOA) in rural areas is a serious concern for human health and the dispersion route of asbestos in the proximity of natural asbestos-rich settings has been marginally evaluated so far. NOA may affect air, but also water and soil quality. In rural areas population may be exposed to asbestos with a largely unknown impact on human health. This work investigates the potential exposure of a farmer cultivating a field nearby the largest former asbestos mine of Western Europe (Balangero, Italy). The concentration of waterborne asbestos in the stream used to water the field was measured (ca. 2×10^5 fibers per liter, ff/L) and the cultivated ultramafic topsoil characterized, evidencing a remarkable occurrence of chrysotile. The worker's personal exposure and the environmental fiber dispersion during a simulated agricultural activity (tillage) were quantified in two independent trials. During the trials, the worker was exposed to average concentrations of 16 and 26 ff/L, with a peak of 40 ff/L. These data inform about the possible exposure of an agricultural worker to asbestos concentration higher than the accepted threshold of 2 ff/L. The release of asbestos fibers into the environment was negligible (0–2 ff/L).

1. Introduction

Asbestos is one of the most harmful occupational carcinogens causing more than 100,000 deaths per year and exposure to airborne asbestos fibers is held responsible for half of the deaths from occupational cancer [1]. Cases of mesothelioma, the fatal malignancy mostly caused by exposure to asbestos, have also been described in individuals exposed to the natural occurrence of asbestos (NOA) or asbestos-like minerals in Turkey, Greece, Cyprus, Corsica, Sicily, New Caledonia, Yunnan province (China) and California (USA) [2,3]. International organizations of health and safety agree on the absence of a "safe" level of asbestos exposure for any type of asbestos fiber, including chrysotile [1,2]. An environmental background level of 2 fibers per liter (ff/L) is widely accepted and is enforced in many national and international regulations (e.g., Italian law on the remediation of indoor asbestos-contaminated environments, DM 6/9/94).

The asbestos route from natural and anthropic sources to human lungs has to be increasingly understood to maximally reduce

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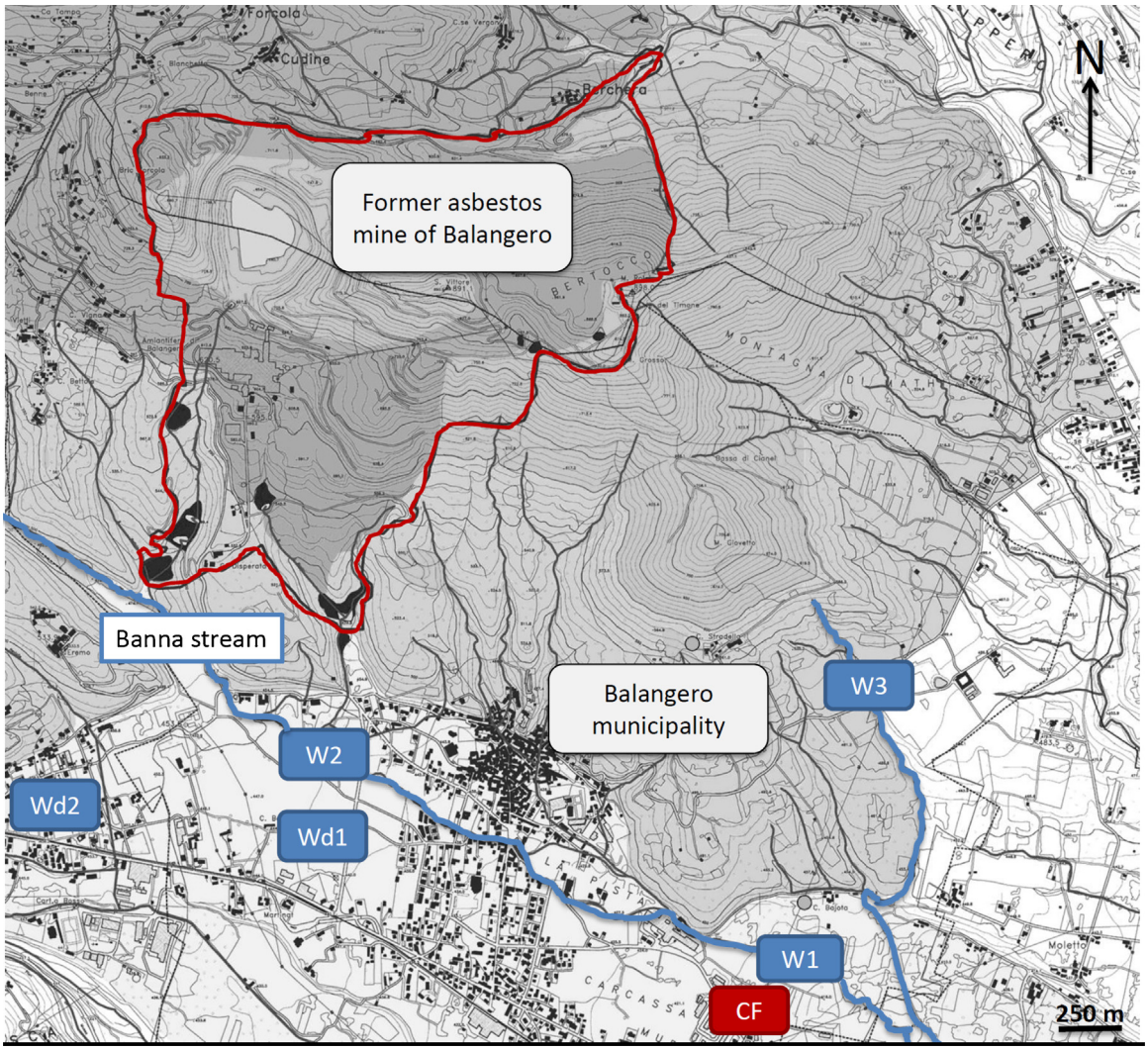

Fig. 1. Study area of Balangero plain. The boundaries of the former asbestos mine are highlighted in red. Superficial water sampling sites: W1, W2, and W3 (negative control); deep water sampling sites: Wd1, and Wd2 (negative control); cultivated corn field (CF), where simulated agricultural operations and soil and air sampling were carried out. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

both occupational and environmental exposures [4]. Environmental asbestos contamination has been primary studied in the air [5], but both water and soil have increasingly deserved the attention of public health agencies and researchers [6–9]. High levels of asbestos fibers have been widely documented in the raw waters of rivers and wells in the surroundings of active and inactive asbestos mines [10–12]. The presence of asbestos fibers in drinking waters has mainly attracted the research interest because of potential direct effects on human health [13–16]. The hydrographic network may also contribute to the transport of fibers in the environment, where asbestos may eventually disperse in the air [17]. In particular, exceptional floods of asbestos-polluted waters were shown to deposit centimeter-thick layers of asbestos-rich sediments on soils [18]. Furthermore, contaminated waters from asbestos-rich natural areas are used for irrigation and livestock watering [19].

In this scenario, soil plays a role as both sink and source along the route of asbestos dispersion [20]. Dry, undisturbed, asbestos-rich soils may generate respirable airborne asbestos fibers [21], but low levels of moisture (5–10%) reduce or completely suppress the fiber dispersion in the air [22]. However, specific studies that assess the risk associated to the exploitation of asbestos-contaminated soils in agriculture or construction are scarce. Only one report on the agricultural practices on an asbestos-polluted industrial ground is available. Authors show a significant increase of airborne asbestos concentration (up to 16 ff/L, fiber length > 5 μm) in the site after soil cultivation [23]. At the best of our knowledge, the exposure of farmers managing waters and soils in the agricultural surroundings of dismissed asbestos mines is still completely unexplored.

To assess if a farmer may be exposed to asbestos fibers, this study: (i) characterizes the occurrence of asbestos in surface waters used for irrigation and in an agricultural topsoil in the proximity of the largest former asbestos mine in Western Europe (Balangero, Italy); and (ii) investigates the exposure to airborne fibers during a simulated agricultural activity. A corn-farmed field irrigated and periodically flooded by waters draining the former asbestos mine was selected. Waterborne fiber concentration was measured and fibrous minerals in the topsoil characterized. The environmental fiber dispersion and the human exposure during tillage were simulated and quantified in two independent trials with different meteorological conditions. For the first time, this work assesses the potential risk of a common agricultural activity in an asbestos-polluted environment, addressing the role of both soil and water as source of natural fibers.