

# Denim sandblasting and silicosis: A 20-year journey

## Kot kumlama ve silikozis: 20 yıllık serüven

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### ABSTRACT

### Öz

Silicosis re-emerged as a critical occupational health issue in 2004 among young workers in Türkiye's denim sandblasting industry. The use of silica-based sandblasting to create a "distressed" look exposed workers to harmful silica dust, leading to progressive lung diseases and increased mortality. A lack of awareness at the time resulted in misdiagnoses, delayed interventions, and unnecessary invasive procedures.

The ban on silica-based sandblasting in Türkiye in 2009 was a significant milestone in occupational health. However, the hazardous practice soon migrated to other countries with weaker regulations, causing similar tragedies. While new exposures have since ceased, the focus today lies on addressing the health needs of affected workers and preventing similar crises in other industries.

The silicosis epidemic underscores the devastating consequences of prioritizing profit over safety. Current priorities include providing comprehensive healthcare to surviving workers and developing proactive policies to prevent future occupational health crises. Global cooperation is essential to enforcing stringent regulations, enhancing worker education, and reshaping consumer demand toward safer practices. These steps are vital to ensure that the lessons of the past 20 years are not repeated in other sectors.

Keywords: Silicosis, Denim Sandblasting, Occupational Health, Silica Exposure, Mortality

Silikoz, 2004 yılında Türkiye'de kot kumlama sektöründe çalışan genç işçiler arasında yeniden ortaya çıkan ciddi bir meslek hastalığıdır. Kotlara "eskitemiş" görünüm kazandırmak için yapılan silika bazlı kumlama işlemi, işçilerin zararlı silika tozuna maruz kalmasına neden olmuş ve ilerleyici akciğer hastalıkları ile artan mortalite oranlarına yol açmıştır. Farkındalık eksikliği, ilk vakaların yanlış teşhis edilmesine, tanıda gecikmeye ve gereksiz invaziv girişimlere neden olmuştur.

2009 yılında Türkiye'de bu işlemin yasaklanması, meslek hastalıklarını önleme konusunda önemli bir adım olmuştur. Ancak, tehlikeli uygulama kısa sürede başka ülkelere kaymış ve yerel düzenlemelerin yetersiz olduğu bölgelerde benzer trajedilere yol açmıştır. Günümüzde artık yeni maruziyet yaşanmasa da silikoz nedeniyle sağlık sorunları yaşayan işçilerin durumu hala önemli bir sorun teşkil etmektedir.

Silikoz salgını, kâr odaklı yaklaşımların güvenlik önlemleri yerine geçirilmesinin yıkıcı etkilerini gözler önüne sermektedir. Günümüzde öncelik, hayatta kalan hastaların yaşam kalitesini artıracak sağlık hizmetlerini sağlamaya ve benzer trajedilerin başka sektörlerde tekrarlanmaması için önleyici politikalar geliştirmeye verilmiştir. Küresel iş birliği, işçi güvenliğini sağlamak için düzenlemelerin sıkı bir şekilde uygulanması ve tüketici taleplerinin güvenli uygulamaları destekleyecek şekilde yönlendirilmesi bu sürecin temel unsurlarıdır.

Anahtar Kelimeler: Silikoz, Kot Kumlama, Meslek Sağlığı, Mortalite, Silika Maruziyeti

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Gönderilme Tarihi: 08/01/2025

Kabul Tarihi: 15/01/2025

Yayınlanma Tarihi: 01/02/2025

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Cite this article: Akgün M. Denim sandblasting and silicosis: A 20-year journey. Ağrı Med J. 2025; 3(1): 48-52.

## Introduction

In 2015, I received an email from a Canadian historian working on a book titled *Fashion Victims* (1). She wanted to include denim sandblasting in her exploration of the hidden dangers behind fashion's glamorous facade—a phenomenon that, at the time, was emblematic of health crises among workers. Reflecting on the story, which began in August 2004, I recognize its profound connection to the lives of young workers and the ongoing struggle to prevent such tragedies.

That year, two young patients arrived at our clinic within a month of each other. The first had been misdiagnosed with tuberculosis and referred to us after a month of unsuccessful treatment. The second, presenting with severe shortness of breath, had been treated for asthma, also with no improvement. Initially, their cases seemed unrelated. However, one detail linked them: both had worked in the same textile factory. When asked about their specific tasks, their responses unraveled the mystery.

One patient's lung biopsy revealed findings consistent with alveolar proteinosis, while the other showed extensive fibrosis. It wasn't until we posed a seemingly simple question—"What exactly did you do in the factory?"—that the pieces fell into place. "We blasted sand onto jeans to lighten their color," they explained. With that, the diagnosis became clear: silicosis, caused by inhaling silica dust from denim sandblasting.

Denim jeans, originating in Nîmes, France, and popularized through Genoa, Italy, transitioned from resilient workwear to a global fashion staple. Initially favored by sailors and factory laborers for their durability, jeans gained cultural prominence in the 1950s, symbolizing youthful rebellion after being immortalized by James Dean. Over time, denim evolved into a high-fashion commodity, with styles such as stone-washed and distressed jeans requiring advanced manufacturing techniques. Among these, the sandblasting process—used to create the "distressed" look—was later revealed to pose severe health risks by exposing workers to harmful silica dust (2).

A year after diagnosing these cases, we submitted our findings to a medical journal. The editor, skeptical that something as seemingly innocuous as sandblasting jeans could lead to silicosis, requested further proof: workplace photographs, dust measurements, or any additional evidence. We could offer only patient histories, biopsy results, and clinical data—but that proved sufficient. The journal published our report, bringing the silent epidemic of denim sandblasting to light (3). This marked the beginning of a journey to uncover the human cost of a fashionable trend that concealed a devastating occupational hazard. Over the years, what started as a clinical observation has evolved into a broader narrative, highlighting the intersections of labor exploitation, public health, and consumer culture.

## A Silent Epidemic Gains a Voice

In occupational health, identifying an index case is pivotal (4). It often serves as the first alert to an unrecognized hazard, catalyzing awareness and interventions. For silicosis linked to denim sandblasting, our initial cases provided the foundation for broader recognition of this devastating occupational disease.

In 2005, we presented two cases of silicosis at the European Respiratory Society (ERS) Congress in Copenhagen. Shortly thereafter, the ERS informed us of similar cases from Istanbul and proposed a joint press release to raise global awareness. This collaboration marked a significant step in bringing international attention to the severe dangers of denim sandblasting. Despite these efforts, the issue failed to resonate in Türkiye, where no media outlets reported on the matter. In contrast, statements by Swedish colleagues following the congress garnered considerable

international attention. Their call for a boycott of Turkish jeans, emphasizing the deaths of young workers linked to sandblasting practices, sparked global concern. Meanwhile, industry representatives in Türkiye dismissed these claims as baseless, offering no substantial evidence to refute the allegations.

Awareness of the issue was limited even within the medical community. The diagnostic errors observed in our initial cases were far from isolated incidents. During military conscription screenings, lung lesions in young workers were frequently misdiagnosed as tuberculosis scars, leading to exemptions from service. These misjudgments not only obscured the occupational origins of their illnesses but also underscored a widespread lack of understanding about the health risks associated with denim sandblasting. This gap in knowledge often resulted in unnecessary diagnostic interventions and invasive procedures, which we suspected could contribute to increased mortality (5).

By 2006, the number of cases at our clinic had grown to 16 young male workers, all previously employed in small workshops producing sandblasted jeans. Their mean age at first exposure was 17 years, with an average employment duration of three years under hazardous conditions lacking adequate protective measures. Many presented with respiratory symptoms, while others sought evaluation after witnessing the illnesses of their colleagues. Tragically, the first two cases died within months of diagnosis, highlighting the severity of this rapidly progressive disease. Initially, we submitted an eight-case series for publication. However, as additional cases emerged, we sought and received approval to expand the manuscript to include 16 cases (6).

The 2008 Landmark Study: Unveiling the Silicosis Epidemic in Former Denim Sandblasters

While denim sandblasting workers primarily lived and worked in Istanbul, the proximity of our hospital in a neighboring province meant that the initial cases were referred to us. This study provided an invaluable opportunity to examine both the working conditions, and the individuals involved in this hazardous industry (7).

The participants, all male, had a mean age of 23 years (range: 15–44) and began sandblasting work at an average age of 17, with some starting as young as 10. Their mean duration of employment in sandblasting was three years, during which they endured prolonged, unprotected exposure to silica dust in dire working environments. Most workshops lacked proper ventilation and relied on inadequate protective measures, such as single-use masks. Alarming, 82% of workers reported sleeping at their workplaces, which prolonged their exposure to silica dust even outside working hours (7). Due to the male-dominated nature of the industry, the diagnosis of a female textile worker, who later became a quality inspector, was delayed in subsequent years (8).

Respiratory symptoms were widespread among participants, with 83% reporting complaints such as dyspnea (52%) and chest pain (46%). Radiological evidence of silicosis was observed in 53% of participants, with stricter diagnostic criteria confirming the disease in 40% of cases. Workers diagnosed with silicosis exhibited significantly reduced lung function, as demonstrated by lower forced vital capacity (FVC) and forced expiratory volume in one second (FEV1). Disease severity strongly correlated with factors such as duration of exposure, number of workplaces, and roles involving more direct contact with silica dust, such as foremen (7).

By 2007, the issue had gained significant attention in Türkiye's media. Although many workers had already left the industry, the sector persisted, employing new laborers to take their place. The findings from this study captured the attention of policymakers, prompting the Ministry of Health to issue a ban on sandblasting

with silica-containing materials in 2009. This marked a critical step toward addressing the hazardous practices of the denim sandblasting industry and mitigating further harm to workers (9). Despite Türkiye's ban, the practice shifted to countries like Bangladesh, where unsafe working conditions continued. Advocacy groups reported that many workers there remained exposed to silica dust without adequate safeguards (2).

In the aftermath of the ban on silica-based sandblasting due to its association with silicosis, the denim industry adopted alternative methods, such as bleaching procedures, to achieve the desired decolorized appearance of jeans. However, this transition introduced new occupational health risks. A study conducted in Kayseri revealed a significant prevalence of occupational asthma among bleaching workers, with rates of 23.8% compared to 9.1% in non-bleaching sections (10).

### **Publications from Other Centers: Expanding the Evidence**

The 2008 landmark study was part of a broader effort to document the silicosis epidemic in Türkiye (7). Early reports from various regions highlighted the widespread nature of accelerated silicosis among workers in small denim factories. Cases from Tokat underscored the hazardous conditions in unregulated workshops (11), while additional reports from Diyarbakır and Malatya revealed similar occupational risks, with four cases identified in Diyarbakır and two in Malatya, further emphasizing the pervasiveness of this occupational hazard across Türkiye (12, 13).

Subsequent studies demonstrated that denim sandblasters face a high risk of silicosis, with rapid disease progression and complications, including death, often deemed unavoidable (14). Another study reviewed 32 silicosis cases diagnosed between 2001 and 2009, noting a 19% mortality rate and a five-year survival rate of 69%, underscoring the aggressive nature of the disease (15). Additionally, a notable increase in compensation claims for silicosis compared to other pneumoconioses reflected the ongoing burden of the disease (16).

### **Additional Insights into the Disease**

Studies on silicosis patients have revealed impacts beyond respiratory symptoms, including upper airway and ocular involvement. Higher rates of rhinitis, adenoid vegetation, elevated nasal pH, and ocular findings such as conjunctival hyperemia and pinguecula were reported compared to controls (17). Radiological investigations have provided critical insights into the disease's progression. Computed tomography (CT) has been pivotal in detecting silicosis, with nodular profusion (primarily centrilobular) as the most common finding and progressive massive fibrosis (PMF) present in 11.4% of cases. Severity correlated with exposure duration and latency periods. High-resolution CT (HRCT) demonstrated superior sensitivity in detecting early nodules, while multidetector CT identified lymphadenopathy in nearly half of cases, with calcifications in 24% (18-20). Challenges in applying the ILO classification system, including low inter-reader agreement in cases with lower profusion scores, underscore the need for improved standardization and training (21). CT imaging has also revealed reductions in thoracic parameters, such as pectoralis major muscle and subcutaneous fat volume, alongside increased pulmonary artery/aorta (P/Ao) ratios. These changes correlate with disease severity, making CT a valuable tool for assessing silicosis progression (22). Dynamic contrast-enhanced MRI (DCE-MRI) has shown potential in characterizing PMF lesions without radiation exposure (23).

Complications of silicosis include pneumothorax, particularly

in acute and accelerated forms, requiring interventions such as thoracostomy and pleurodesis (24). Tuberculosis remains a significant concern, with silica exposure as a major predisposing factor. Cases of silicosis co-occurring with infections like *Echinococcus alveolaris* suggest a compromised pulmonary environment (25-26). Between 2009 and 2017, 10 of 142 sandblasters with silicosis were diagnosed with rheumatological diseases, including systemic sclerosis, rheumatoid arthritis, and lupus. These cases showed elevated markers of systemic inflammation, such as LD, sedimentation rate, and CRP (27). The psychosocial burden of silicosis is profound. Factors such as dyspnea, witnessing coworkers' deaths, societal stigma, and difficulties finding new employment exacerbate isolation, depression, and anxiety. Studies using tools like SF-36, BDI, and BAI have shown significantly lower quality of life and higher depression and anxiety levels in silicosis patients compared to controls (28).

### **The Temporary Compensation Right: A Missed Opportunity for Equity**

The landmark 2008 study exposed critical systemic failures within the denim sandblasting industry, including unregistered workplaces, lack of social security for workers, and hazardous conditions that contributed to a silicosis epidemic (7). After the ban on sandblasting, many former workers were left without jobs, social security, or means to support themselves. While some had succumbed to the disease, others were debilitated by its effects, unable to work due to both their declining health and the stigma surrounding their condition. In response, a legal regulation was introduced, granting silicosis patients free healthcare and later extending compensation rights. However, the program's significant limitation was its narrow application window: only those who applied within a three-month period ending in May 2011 were eligible. This excluded individuals whose disease had not yet advanced to diagnosable levels, despite silicosis being a progressive condition.

A follow-up study conducted in 2011 further highlighted the inadequacy of this temporary provision. It reassessed 83 of the 145 former sandblasters initially evaluated in 2007 (29). Over the four-year period, nine workers (6.2%) had died at a mean age of 24 years. Among the 74 surviving workers, the prevalence of silicosis had risen sharply from 55.4% to 95.9%. Radiographic progression was observed in 82% of cases and was linked to factors such as younger age, non-smoking status, foreman roles, and sleeping at the workplace. Pulmonary function loss, present in 66% of cases, further underscored the progressive nature of the disease. These findings revealed that many workers who appeared healthy at the initial evaluation later developed significant disease, exposing the inherent injustice of a compensation program limited by a short application period.

A subsequent 10-year follow-up study reinforced these findings. All sandblasters included ultimately developed silicosis, including those who were radiologically classified as healthy (ILO category 0) at baseline. The number of workers with advanced disease (Category 3) increased 2.5-fold, and 11 workers developed new large opacities. Radiological progression was strongly correlated with the duration of silica exposure and accompanied by significant pulmonary function decline (30).

### **Former Jean Sandblasters Die Younger**

After reporting the first two cases of silicosis among denim sandblasters, both patients died shortly thereafter, highlighting the disease's aggressive progression (3, 6). Follow-up studies further documented deaths within the 2007 cohort, emphasizing

the urgent need for data quantifying mortality relative to the general population (29, 30). From 2008 to 2023, a study in Taşlıçay and Toklular villages, Türkiye, compared mortality rates between 220 diagnosed silicosis patients and 2851 undiagnosed community residents (31). Over 15 years, silicosis mortality reached 10%, significantly higher than the 4% in the general population. Mortality risks were higher for patients with elevated radiological profusion scores, younger age at diagnosis, and prolonged silica exposure, with a profusion score above five increasing risk by 1.37 times (31).

Additional studies confirmed these trends. A retrospective review (2006–2017) identified predictors of premature death, including large opacities, tuberculosis, and pulmonary function loss (32). Among denim sandblasters, mortality risk rose by 9% for every additional month of silica exposure. Five-year survival rates for patients with A, B, and C opacities were 88%, 67%, and 25%, respectively (33). Furthermore, research into HLA polymorphisms found HLA-B51 associated with milder disease, while HLA-B55 and HLA-DR4 were linked to severe cases (34).

This evidence underscores silicosis's progressive and fatal nature, particularly among young workers exposed to silica. Factors such as early exposure, prolonged contact, severe radiological findings, and impaired lung function highlight the need for preventive measures, better healthcare access, and consideration of lung transplantation for advanced cases.

## Preventing Silicosis and Treating Its Consequences

Silicosis is a preventable occupational lung disease. Unlike many non-communicable respiratory conditions, its proximal causes—such as exposure to crystalline silica—are well understood. Effective preventive measures, including water suppression, ventilation systems, and personal protective equipment, can significantly reduce risk. However, in regions with informal and unregulated workforces, these controls are often absent, leading to alarmingly high rates of silicosis (35). Prevention is crucial, as treatment alone cannot address the severe consequences of this disease.

Research into silica-induced lung inflammation has identified critical pathways, such as the STING-mediated response. Silica exposure triggers lung cell death and the release of self-dsDNA, activating inflammatory cascades. Human studies have confirmed elevated levels of circulating dsDNA and CXCL10 in silicosis patients, aligning with findings from animal models. This research suggests potential therapeutic options, such as DNase I, to mitigate inflammation (36).

A growing epidemic of silicosis has emerged among workers in the artificial stone industry, where engineered stone contains over 90% crystalline silica. This leads to shorter latency periods, rapid disease progression, and higher mortality rates. Workers exposed to materials such as phthalic anhydride and epoxy resins face additional risks, including asthma and connective tissue diseases. In response, countries like Australia have banned engineered stone, highlighting the need for global action to address this escalating crisis (37). For advanced silicosis cases, comprehensive care becomes essential. Among workers in the artificial stone industry, lung transplantation has increasingly become a necessity due to the disease's rapid progression. Ensuring access to transplantation and providing robust healthcare support are vital to mitigating the long-term impacts of silicosis (38).

## Conclusion

Silicosis, an ancient occupational disease, has re-emerged

in new contexts, such as denim sandblasting and artificial stone industries, highlighting the ongoing risks of silica exposure. After its ban in Türkiye, the practice shifted to neighboring countries and eventually Bangladesh, causing similar outbreaks. This global trend demonstrates that banning harmful practices without addressing systemic issues merely shifts the problem, perpetuating preventable harm.

The denim sandblasting crisis, identified nearly two decades ago, has led to widespread disability and premature death, driven by profit-focused decisions that ignored worker safety. These tragedies underline the need for robust regulations, worker education, and effective protective measures. Governments must lead in safeguarding worker health, while consumer awareness and cultural shifts are crucial to reducing demand for harmful practices tied to fleeting fashion trends.

To prevent future tragedies, it is essential to address past failures, strengthen regulations, and commit globally to worker safety. By prioritizing prevention, awareness, and accountability, we can build a more ethical and sustainable future that values human lives over economic gains.

## Conflict of Interest

There is no conflict of interest

## Funding

There is no funding support for this study

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