**Introduction**

Silicosis is a chronic, non-malignant, potentially fatal, fibrotic and diffuse occupational lung disease with no specific cure (1-3) for which several classification systems exist, but which is at best irreversible and sometimes progressive to the point of mortality, even long after the exposure has ended. The continuous inhalation of silica particles of an intensity and duration sufficient to cause silicosis is 41 ± 27 months, a brief exposure period (4). Despite all efforts of prevention, silicosis still affects millions of workers in hazardous occupations and kills thousands every year globally; however the burden is under-reported due to poor regulatory measures and surveillance (5). Specifically, the risk of silicosis in sandblasting workers is notoriously high due to the significant silica exposure.

Silicosis is usually associated with mining, tunneling, quarrying and certain other professions and until recently there has been a dearth of published cases implicating garment manufacturing. Sandblasting is a process of smoothing, cleaning, stripping, strengthening and polishing a hard surface by forcing solid particles at high speeds using compressed air. This physical, mechanical and water-free technique is part of the so-called “dry” process in garments washing, which creates localized abrasion or color change on the denim modifying its outlook and appearance with no chemical use or dying; thus has become the key method for finishing most modern jeans requiring a ‘worn-out’ look.

Demand for pre-worn denim has led to a massive rise in its use, but fashion comes at a price: the health and even the lives of sandblasting workers. Most factories use sea sand rich in silica and if/when inhaled, they penetrate the lungs and lodged at the level of the alveoli, create permanent alterations in lung architecture known as silicosis after a couple of years of exposure. Although widespread throughout the world, the first time silicosis was associated with denim sandblasting was in Turkey in 2005 (1).

This study aims to examine the relationship of silicosis with denim sandblasting, drawing on the Turkish experience, where workers who were weak, insecure and invisible through economic, social and political factors, showed their potential with allies to transform the situation. A literature review on globalization and informal work, how they affect the economic and political aspects of life and garment manufacture, and the past and present occupational health consequences of globalization is performed. A historical perspective is given to reveal the role of the national and international campaigns in procuring the ban on denim sandblasting and the social and legal reforms. A case study on denim sandblasting in Turkey is conducted by carefully highlighting the stages involved to illustrate Turkey's experience of the primary role of civil society and denim workers' right of access to healthcare and provide a learning point for other countries on dealing with occupational health hazards.

Since Turkey's experience has much to offer to other developing countries, where sandblasting of garments remains an on-going threat to workers' health; this study draws specific conclusions on what currently is unique to Turkey, but may inspire similar success abroad, making recommendations for the Turkish experience to be replicated in other developing countries.

**Methods**

This exploratory case study acknowledges the actions and activities of the Solidarity Committee of Jeans Sandblasting Laborers (hereby referred to as the Committee) based in Istanbul. For this purpose, we employed a qualitative approach, seeking to identify the key themes and ideas. We sought to understand how members of the Committee frame and articulate their political and civic involvement to the cause and also the pathways they pursued to reach their goals. We analyzed national policy and debates on sandblasting, and the observations of the principal investigator, who participated in the campaign from 2008-2012, and reflected the views expressed within interviews conducted with key informants who were members of the Committee.

Eleven core members of the Committee worked to obtain social rights for denim sandblasting workers throughout the entire episode. Three members of this group consented to provide interviews: a former denim sandblasting worker, who was the most active member in terms of campaigning; a physician who became a well-known public figure in all scientific and public activities; and a journalist who took an active role in the Committee’s press and public relations. The principal author of this article is also a former member of the Committee. An interview guideline consisting of 16 open-ended questions inquiring the turning points and critical achievements in the history of this civil initiative was developed. Data was collected between April to December 2015, followed by the review of all collected documents, meeting notes, news clips, articles and reports on the various activities of the Committee. Thematic analyses to understand historic progression and key events were compiled and presented under different themes that are thought to play a major role both in the denim industry and health of workers.

**Implications of Globalization on Sandblasting and Health**

Vintage-seeming jeans symbolizing freedom and comfort have a social appeal that cuts across gender and class boundaries. Of the 5 billion jeans manufactured worldwide annually (6), a high proportion is vintage. Denim sandblasting started in Italy in 1988 (7). It is a technique beneficial to the producers as it is both cost-effective and demands only unskilled labor to accomplish.

Having an income is integral to well-being, necessary for a decent standard of living and a means of meeting basic needs and building capabilities (8). The conditions in which people work is one of World Health Organization’s (WHO) social determinants of health and there is an extensive literature on how physical, chemical, biological or psychological factors that cause ill health at workplaces, namely the occupational diseases. Workers spend almost 1/3 of their lives at work, and they get exposed to several hazards. WHO defines occupational health as “... all aspects of health and safety in the workplace, and has a strong focus on primary prevention of hazards” (9).

The long-term harmful effects of occupational diseases include chronic respiratory, musculoskeletal, audiological, dermatological and the work-related non-communicable diseases including cancers, circulatory diseases and stress-related disorders (10). Occupational risks are among the top 12 overall risk factors for disease burden globally (11,12) and work-related health problems result in an economic loss of 4–6% of Gross Domestic Product for most countries; yet about 70% of workers do not have any insurance to compensate them in case of occupational diseases and injuries (10). Silicosis, known for centuries, with its potential to cause progressive and permanent physical disability, is incurable yet perfectly preventable, and still occurs in many countries and occupational settings both in developed and less-developed countries (13).

Workers in developing countries disproportionately bear the brunt of work-related diseases and injuries. The problem arises from the globalized system where multinationals shift risk from high-income to low-income countries. Globalization has long been assumed to strategically resolve the engrained problems of unemployment and poverty in both developed and developing nations by sustaining economic growth, reducing barriers against free trade and transferring technology and capital between countries (14,15), thus enabling poor to benefit from more resources, and also claim their democratic freedoms and human rights due to government policies that is expected to follow.

However, costs associated with globalization outweigh the anticipated benefits; it generates greater inequalities in the distribution of income- making the rich richer and the poor poorer; exploits the global workforce to developing countries yet to be exploiting their labor against social welfare standards, and worker protection legislation to lower the costs. The negative impact of globalization - especially on vulnerable sections of the community results in the violation of various rights, such as freedom from cruel, inhumane or degrading treatment and servitude, equality and non-discrimination, just and fair conditions of labor, and collective bargaining (16).

In developing countries informal employment is often seen as a panacea and comprises more than one-half of non-agricultural employment in most regions of the developing world (17), playing a major role in creating jobs, providing income, increasing production and employing those who would otherwise be without work or income (18,19). Informal workers are estimated to number 1.8 billion (50-90% of the global workforce), and differ in occupation, social and legal status (12,20,21). Informal employment- or "precarious" as labelled by ILO (18), leaves the workers at risk of wage slavery, limited security, no social protection and inhumane and unsafe working conditions.

The working conditions in precarious employment are linked with adverse occupational health and safety (OHS) outcomes, and studies show greater risk for temporary workers than permanently employed and a higher incidence of workplace injury (22) due to exposure to the most hazardous labor and poorer conditions. Furthermore, temporary workers are harder to protect due to lack of/less access to OHS professionals and trainings, affordable and quality healthcare, and regulatory enforcement of OHS standards (10), thus prone to poor health, injury and illness (20,23,24). Occupational diseases, which become rarer in developed countries, are actually increasing in developing ones (25).

**Jeans Sandblasting in Turkey**

1. **Sandblasting in Textile Industry in Turkey**

Turkey has been a key textile and ready-to-wear garment player worldwide for many years, success being predicated on technical know-how and geographic location. Export market share in these areas has increased since the mid-1990's; and in 2008, Turkey was the world's third largest denim exporter, with a turnover of 2.3bn USD and 300,000 workers in this industry (6).

During the 1990's, when the fashion for jeans shifted from pristine to old/used-looking, the clothing industry largely outsourced production to as yet unregulated countries including Turkey, Bangladesh, and China due to the imposition of strict regulations on sandblasting in many European countries. The first known operation in Turkey was in 1997 (7).

Turkey, with its large population of working age and low labor costs, simultaneously became central in the denim industry. Small and medium-sized factories, aided by the large informal economy, sprang up, especially in Istanbul. It was estimated that there were more than 1,000 workshops in Istanbul alone in 2005 (7). 2010 data showed that 44% of overall employment in Turkey was informal (26), with two-thirds of informal employment in textiles and garment manufacture. Nearly comprehensive OHS legislation was in practice hampered by non-enforcement due to low monitoring levels. Thus, an environment favorable to investment in denim manufacturing grew up in Turkey. Operators were primarily young, male migrants, with the average employment age of 16 (7), from distant parts of Turkey or immigrants from Azerbaijan, Georgia, Romania, Moldavia and Bulgaria who were employed mainly in workshops functioning as subcontractors of global brands (6,27). Majority were uninsured, and the average exposure time was estimated to be around two years (7). Working in conditions, which optimized sand use (narrow, closed and unventilated workspaces) at the expense of concern for occupational hazards has proven highly detrimental to operators' health.

1. **First documentation of health effects**

It was in Turkey that the negative health effects of sandblasting process in the garment industry were recognized, with Turkish doctors being the first to sound the alarm over silicosis amongst garment sandblasters (1,28). There was a lag between the period of highest prevalence of the sandblasting technique in the late 1990's and the first scientifically validated case series on denim sandblasters published in 2005. Initially, in the early 2000's, misdiagnosis of silicosis with tuberculosis or asthma was frequent in such workers (3) or viewed as sporadic.

In 2005 the first major study to link sandblasting jeans with silicosis was published. In this landmark publication, Akgun and colleagues reported two denim garment manufacture-related cases with massive silica exposure amongst non-smokers aged 18 and 19 in Erzurum, Turkey (28). Within two months, some 35 additional cases from four cities involved in the industry were published by pulmonologists (29). A flood of cases followed (1,4,30-35).

Despite a paucity of reliable data, experts estimated the numbers involved in denim sandblasting from the mid-1990s to the nationwide ban in 2009 as 5-15,000 individuals (6,36,37). Four to five thousand of these workers reached the diagnostic threshold for minor, moderate or severe silicosis. What initially appeared to be sporadic cases eventually took on the dimensions of an occupational disaster. At the time of writing, 2200 such cases are registered, with 101 confirmed deaths.

1. **The Solidarity Committee of Jeans Sandblasting Laborers for social justice movement**

This glimpse of the hidden iceberg was a call to arms for people with no other connection than shared awareness and concern about informal workers lacking a voice. The Solidarity Committee of Jeans Sandblasting Laborers ("The Committee"), a voluntary civil initiative composed of individuals with many different backgrounds, was formed in June 2008 to raise public awareness, advocate for workers' social rights and press for legal reform. Its members included ex-sandblasters, physicians, lawyers, social workers, academics, journalists, artists and labor activists. This group of activists convened regularly to implement strategies in response to changing conjuncture. The domestic struggle inspired worldwide efforts and support came from such well-known international non-governmental organizations (NGOs) as the Clean Clothes Campaign (CCC), the organization that aims to improve the working conditions of people within the garment industry, took the ban to the global agenda.

The Committee facilitated access to medical care via free transportation to hospitals, monitored hospital admissions, corrected the duplicated records from Ankara, Istanbul, Erzurum and Diyarbakır to allow a truer picture of the epidemic to emerge. Former workers in the industry provided evidence and "insider" information necessary in preparing a road map for change. A regularly updated website increased public support and facilitated timely dissemination of information. A variety of stakeholders, political parties, scientists, universities, NGOs and trade unions were active in discussion. Media appearances were undertaken by members of the Committee featuring real-life silicosis stories in detail (38).

1. **Impact of Activists (“The Committee”) on visibility of laborers and public opinion**

Public awareness was vastly increased via Arena, a popular TV show. Many workers began self-presenting at hospitals, even when asymptomatic, as a result of concern over employment in the industry or following case identification amongst colleagues. There was an apparent abrupt rise in case registrations and mortality, but, given the informal nature of their employment, most such patients found themselves not entitled to legal rights or benefits. Cases where the disease was so severe as to preclude further paid work lacked entitlement to an "occupational disease report" or temporary/permanent incapacity state benefit. The consequence of their unrecognized legal status was a return to their previous abode with the expectation of a lingering death.

In the interim, victims undertook a class action with the assistance of lawyers working *pro bono*, the aim of which was to establish linkage between informal employment and employer liability. Whilst criminal prosecution was being prepared against employers accused of causing disease and death through inhumane conditions, simultaneously a case was being prepared against the Ministry of Labor and Social Security (MoLSS) stating that it had failed in its duty to “organize and control working conditions, employer-employee relations and occupational health and safety; take and impose necessary measures to ensure occupational health and safety; guarantee, mainstream and develop social security coverage” and had not prevented employment under such poor conditions. Litigation targeting local authorities for deliberately ignoring workshop activities that would have failed licensing requirements by not providing essential OHS equipment was undertaken. The Committee's legal team organized the filing of complaints.

In major cities, marches happened raising public awareness and increasing pressure on the government. A petition featuring leading Turkish intellectuals and artists was produced. Two massive benefit concerts using the title "Your Breath is Our Voice" (“Sesimiz Nefesiniz”) brought revenue used for transportation and legal fees. Two documentaries filmed by volunteers were widely screened at meetings: The Return ("Dönüş") based on the human story of the victims, The Dust ("Toz") based on the legal struggle.

The issue was discussed in the Turkish parliament and investigations were launched. The Committee wrote to parliamentary representatives enclosing monographs, and visited the Turkish parliament five times to talk to deputies and ministers and submitted a draft law proposal. The Ministry of Health (MoH), MoLSS and the Parliamentary Human Rights Commission discussed the issue and raised concerns. The Turkish President also met with the Committee members.

1. **Tangible Results**

On March 27, 2009 the MoH issued a circular entitled “Ban on Sand Use in Denim Abrasive Blasting” prohibiting “the use of any material containing sand (silica dust) or crystalline silica in abrasive blasting applied on jeans or other types of cloth”, then the Ministry of Health promised free treatment for all silicosis patients. Problems resulting from a lack of procedural clarity were rectified by the Council of Ministers in January 2010 such that all state hospitals then provided free treatment to silicosis patients irrespective of social security status (38). Two provisional clauses were added to laws numbered 6111 and 2022 in the Turkish Legal Code giving an entitlement to a disability pension in proportion to impairment whatever their social security status and irrespective of other income, this entitlement passing to their heirs on their death. Approximately 1000 individuals have benefited from this provision, although a deadline, which is opposed by campaigners, has meant many who failed to meet the deadline have now lost their entitlement.

**International reactions and progress**

Major steps have been taken globally. The Joint ILO/WHO Committee on Occupational Health identified the global elimination of silicosis as a priority area for action in occupational health; and following their recommendations in 1995, ILO and WHO have joined forces to launch the Global Program for the Elimination of Silicosis (GPES) as an international technical cooperation program. Given the tripartite structure of ILO dealing with government, employers, and workers, GPES shaped a policy perspective between countries and international organizations with an approach that requires “every actor to have a responsibility”. Countries were required to launch national programs covering legislation, health surveillance and improvement of technical standards as necessary. To date, Brazil, Chile, China, India, Peru, South Africa, Thailand, Turkey, and Vietnam have established their National Programs for the elimination of silicosis (25,39).

Following the implementation of the ban in Turkey in 2009, the Killer Jeans Campaign (40) was launched in 2010 by CCC calling for a global ban on denim sandblasting. Briefing notes were dispatched to the MoHs of Azerbaijan, Romania, Moldova and Georgia in line with the countries of origin of affected workers (41). The media outside Turkey, such as Arte, ZDF, Le Figaro, Le Monde, Der Spiegel, TV5, Le Nouvel Observateur, carried items featuring silicosis victims in response to activities of the Committee and raised public awareness. Subsequently, the Committee formed alliances with CCC, the International Textile Garment & Leather Worker’s Federation (ITGLWF), the International Liaison Committee (ILC), the European Trade Union Federation: Textiles, Clothing, Leather (ETUF-TCL) and many other labor organizations and NGOs. CCC’s call for an “urgent appeal” and “killer jeans” campaign achieved a wide impact.

Over 50 well-known jeans brands adopted the ban and announced cessation of garment sandblasting after the practice was proven to cause fatal lung diseases, including silicosis. In August 2010, Levi’s and H&M announced in a press conference that they had entirely banned the use of silica through abrasive blasting in their denim manufacturing workshops all around the world. Many brands including Armani, Mango, Gucci and the like, followed suit.

Since then, production sites have shifted to countries where occupational regulations are poor, such as China, Bangladesh (42,43), Pakistan, and parts of North Africa (44,45). Most factories in Bangladesh, where the garment industry is the eminent export-oriented sector, do not meet national and international standards of building and construction legislation, safe working environment, labor rights, etc. The collapse of Rana Plaza in Bangladesh in 2013 was the consequence of such non-compliance and is regarded as the deadliest disaster in the history of clothing manufacturing industry (46). The report by CCC, found that regardless of whether a brand has ‘banned’ sandblasting or not, large factories exporting jeans overseas continue to use sandblasting (42).

**Discussion**

Globalization of silicosis hazards brought discussions about the duel between benefit-driven industry and NGOs defending human rights and social justice (47). Kulkarni, claiming the prevention and control of silicosis a 'national challenge' in India, proposed a national strategy that compasses active cooperation and involvement of all stakeholders, including the community, mass media and NGOs (48). The scale of Rana Plaza incident raised global debate and attention over workers' and workplace safety, and led to the creation of the Rana Plaza Arrangement to compensate the affected and the Accord on Fire and Building Safety, with the support and campaigning of CCC (49).

Often criticized for glossing over the silicosis issue and focusing on awareness-raising campaigns solely on environmental concerns, as in Greenpeace's campaign with the Sherpa Association in Niger, where the end-report mentioned silicosis only once (50); and for acting as part of multi-stakeholder solutions that give victims hope but in reality violate their fundamental rights (51); international NGOs depend on local NGOs which, despite their limited means, make silicosis a priority and defend workers' rights (48); such as the Hong Kong based Asia Monitor Resource Center that organized campaigns and the 2006 meeting with local NGOs in Baroda, Gujarat, to denounce poor working conditions in gemstone-treatment workshops (50); the People's Training and Research Centre, a nonprofit voluntary organization in Vadodara, Gujarat, that under a project supported by the Gujarat Ecology Commission in 2002 implemented programs to bring attitudinal change in the local community regarding safer technology (52); Action for Southern Africa that commenced 'Justice for Southern African Gold Miners' campaign in 2012 demanding medical screening, financial compensation, healthcare and support for those suffering from these diseases, leading to High Court approved class action settlement of £268 million as compensation to eligible gold mineworkers and their dependents in 2019 (53,54); the Occupational Safety & Health Association of Jharkhand whose research led to Supreme Court ordering a report on the conditions of workers in industries with risk of silicosis across Jharkhand in 2016 (55).

A number of key themes emerged from the data collected. Most notably, before meaningful change could occur, the public needed to be made aware of the problem and a gradual build-up of pressure was necessary before a turning point could be reached. Vital to this build-up was the combination of advocacy, campaigning and the mobilization of segments of society to support the affected workers. Whilst the details of which action finally forced the change do not emerge clearly from our data, the impression of a building pressure clearly does. Legislation alone appears to be ineffective, since widespread disregard for legislation nullifies its force. Only when legislation was backed up by enforcement did the law begin to take effect.

Denim sandblasting is a typical example of how rapid globalization has led to the transfer of hazardous production processes and subsequent occupational risks to developing countries where regulatory frameworks are inadequate, and labor organizations are weak (56). This also accounts for sandblasting jeans being so prevalent in Turkey. Along with some other Eastern European countries, Turkey has become a base for operations rather than those countries in Asia, due to its geographical proximity to Europe and favorable economic environment for investment (57). Denim sandblasting also makes an excellent case study for factors causing occupational diseases such as asbestosis and silicosis the prevalence of which has substantially been reduced in industrial countries yet still exists in developing countries (25).

In Turkey’s case, workers in denim sandblasting matched the profile for vulnerable workers: young, male, poor, unskilled, unemployed and uneducated and with origins in Eastern Anatolia. A difference between denim sandblasting and other informal employment was in higher wages, which acted to overcome objections to the poor physical conditions as previously outlined. Their disadvantageous situation meant these workers could not negotiate social security benefits or better working conditions. Thus, their only alternative was informal employment, whatever the conditions offered.

Even formally employed workers in Turkey have inadequate preventive, diagnostic and rehabilitative occupational health services. But this legal position entails workers having the right of diagnosis and compensation including in case of their death. The gap between predicted and observed cases of occupational disease (for example, the total number of occupational disease cases recorded for 2014 and 2015 were a mere 494 and 510 respectively) can be explained as due and poor detection (58,59).

Turkey achieved a certain amount of success in handling the problem, but there still remains much to do. The Turkish “National Action Plan for the Prevention of Pneumoconiosis” that became effective as of December 2006 set short, intermediate and long-term expected results for 2008, 2010, and 2015 respectively. However, the decisions taken by the MoH, though important, are only a partial solution. The Ministry has not launched a nation-wide campaign to call former denim sandblasters (with or without silicosis) to attend occupational health check-ups.

Currently, despite the existence of this action plan and the following “Communiqué on Applications Regarding the Struggle with Dust” in 2014, implementation is not coercive, and the long-expected results remain overdue, with few concrete successes. Recent studies indicate that due to its non-specific clinical symptoms and unrecognizable shadows on x-rays in the early phase of the disease, silicosis may fail to be recognized and tends to be underestimated (35); currently the disease persists to be a health threat; and depending on the time span since the date of the ban being consistent with the reported medical evidence for the development of symptoms, patients do consult pulmonology clinics for diagnosis (56). Finally, there are no set program indicators for many of the expected results in the Action Plan, which makes monitoring almost impossible. Therefore, Turkey needs to keep up the pace and continue its efforts to deal with this serious problem.

On a global level, given the prevalence of silicosis in countries that have not prohibited the use of sandblasting, Turkey’s 2009 national legislation towards the elimination of silicosis should be a precedent for other countries to follow in order to take action as well. A comprehensive and combined effort by the governments, NGOs, private sector, labor organizations, international organizations, physicians, people within the supply chain and also the community are expected to come up with effective measures to prevent the development of silicosis due to this type of occupation- even to end all forms of sandblasting; and also ensure that the vulnerable populations are informed about silicosis (56).

**Conclusion**

At workplaces people experience diverse exposures, both occupation-specific and non-specific, leading to work-related diseases and injuries. Estimates are that more than 1.2 million deaths (2.1% of global deaths) were attributable to occupational risks in 2015 (60). Although there is sufficient evidence that primary prevention through feasible and cost-effective interventions is highly effective, the risks are disproportionally high in specific countries and occupations, affecting mainly lower socioeconomic groups. Pneumoconiosis, the group of chronic respiratory diseases including silicosis, are 100% attributable to occupational risks, and avoidable, yet annually cause over 20.000 deaths (60,61). Silicosis constitutes a prominent public health problem affecting millions worldwide (2) mainly due to its large share of informal workers.

Anand and Sen (8) drew from the framework of sustainable development and its emphasis on the rights of future generations to obtain capabilities that enable them to lead satisfying lives. They argued that what is to be sustained cannot include the deprivation and vulnerability of current generations. They conceptualized human development and alleviation of deprivation as ends in themselves rather than as instruments to reach sustainable development goals and as significant factors in the realization of ethical universalism. The deep-rooted mentality and the establishment of effective instruments for human development would improve various aspects of life for both current and future generations. From this approach, informal work conditions coupled with the widespread use of hazardous materials in production cannot be sustained to the future generations.

Although organizations such as WHO, ILO and CDC took action towards prevention and elimination of silicosis, and recommended a hierarchy of elimination and substitution of the hazard, engineering and administrative controls, and personal protective equipment (62,63), further national and international action towards broader implementation and effective intervention with a comprehensive public health approach of developing policies, guidelines and legal frameworks for workers’ health and strengthening mechanisms and capabilities to reduce the burden of unhealthy workplaces is needed. Activities promoting the public identification and recognition of the health damages intertwined with social and economic problems of the sandblasting workers are significant for awareness-raising at both societal and legal/governmental levels to alleviate the deprivation of workers emanating from their working conditions. Bringing this issue to higher mechanisms through social mobilization helps the inclusion of those who are affected and would support the realization of ethical universalism.

Sandblasting workers and their stories need to be heard and their suffering recognized. Academic research and teaching institutions have been of great support so far; but further epidemiological research, both quantitative and qualitative, and data collection is needed to identify the real numbers of people involved as well as monitoring the workplaces properly. The changes in Turkey are good news but cannot be the end of the story.

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