

CHINA'S "MARKET ECONOMICS IN COMMAND": FOOTWEAR WORKERS' HEALTH IN JEOPARDY

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This study of occupational safety and health (OSH) problems in the footwear industry in China, the world's largest shoemaker, is based on four years of research in China supplemented by research in Taiwan, Australia, and the United States. With the advent of the economic reforms of the early 1980s, the Chinese state is being driven by an economic imperative under which the profit motive overrides other concerns, causing a deterioration in OSH conditions. Footwear workers are being exposed to high levels of benzene, toluene, and other toxic solvents contained in the adhesives used in the shoe-making process. Many workers have been afflicted with aplastic anemia, leukemia, and other health problems. Most of China's current permissible exposure limits to toxins are either outdated or underenforced. As a result, the Chinese state's protection of footwear workers' health is inadequate. The article aims to draw the attention of the international OSH community to the importance of setting specific exposure standards for the footwear industry worldwide.

An intense debate has been raging for several years in the United States among labor, human rights, consumer, and religious groups over the poor work conditions in the apparel industry (including multinationals such as Nike and Liz Claiborne) in countries—especially those in Asia—that make a large percentage of the shoes and clothing worn by Americans. The adverse publicity caught President Clinton's personal attention, resulting in the formation of a Presidential Task Force. The warring parties were brought to the negotiating table, and in April 1997 (1) agreed to sign an initial "landmark agreement," the Apparel Industry Partnership, which drew up a Workplace Code of Conduct for the Partnership's multinational members (2). But agreement on the practicalities of how to monitor the Code took another one and a half years. In November 1998 some

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members of the Partnership announced the creation of the Fair Trade Association, which will be entrusted to oversee the corporate members' adoption of the Code (3).

Our concern over the debate is that the Partnership has focused lopsidedly on the issues of wages, optimum length of working hours, and the right to collective bargaining, without paying enough attention to occupational safety and health (OSH) problems. These problems are particularly severe in the footwear industry owing to the toxic solvents in the adhesives used for gluing together the various parts of shoe uppers and bottoms. The only reference to OSH in the Code is too general and vague to provide any meaningful guideline for practical implementation. Under the section "Health and Safety" it reads, "Employers shall provide a safe and healthy working environment to prevent accidents and injury to health arising out of, linked with, or occurring in the course of work or as a result of the operation of employer facilities" (4). Inasmuch as the United States is the world's largest consumer and importer of apparel products made for export, the Code has immense repercussions for workers in the international apparel industry. This article analyzes the nature of the footwear industry OSH problem in the hope that the Fair Trade Association, including its critics and the world community concerned with OSH, will consider setting and enforcing specific OSH exposure standards for the various toxins that are prevalent in the industry and other specific guidelines for the protection of footwear workers' health. The present OSH clause in the Code is simply too vague to be enforceable.

To comprehend the scale of the problem in Asia, we have to start with China, not least because China is the world's largest shoemaker—4 billion pairs a year. Made-in-China shoes constitute fully 40 percent of the world's annual shoe output (5). In 1996 the United States imported just under one billion pairs of shoes from China, which constituted about half of U.S. shoe imports (6).

DATA COLLECTION AND METHODOLOGY

This article is an outgrowth of two separate research projects, in progress for the past four or five years. One project is on the patterns of industrial relations in China, using the footwear industry as a case study; the other is on OSH problems in China and Taiwan. These are supplemented by research in Australia and the United States to provide a comparative perspective.

We report here on four aspects of this research: (a) the OSH hazards in the footwear industry in general, and in China in particular; (b) the historical background of the OSH situation during the Maoist period; (c) the OSH situation in China under market reform in the post-Mao period in footwear factories of all ownership types: state, township and villages, domestic private, and foreign-funded; and (d) China's OSH standards in comparison with standards of a few selected countries. Our research data include the following:

1. Studies on OSH hazards in the footwear industry published in Western, Chinese, and Taiwanese scholarly journals (some of the latter are published in Chinese).
2. Chinese-language newspaper and magazine reports on the industry.
3. Field observations based on visits by a five-member research team to some 70 footwear factories of all ownership types in seven Chinese cities over three years—1995, 1996, and 1998. The cities are Beijing, Tianjin, Shanghai, Dongguang, Chongqing, Putian, and Jinjiang. These are supplemented by visits to five shoe factories in Australia in 1994 and 1997, and five factories in Taiwan in 1998.
4. Interviews conducted in 1997 and 1998 in Taiwan with the managerial staff of adhesive manufacturers from whom many Taiwanese factories operating in Mainland China obtain their adhesives.
5. Interviews with several owner/managers of footwear factories in Taiwan who have investments on Mainland China. Interviews with two Australian footwear owner/managers in 1997.
6. Interviews with trade union officials, OSH officials, and OSH academics in China, Taiwan, Australia, and the United States.
7. For comparative purposes, data on OSH standards and regulations related to the protection of footwear workers' health in China, Taiwan, the United States, Australia, the European Community, and the former USSR.

OCCUPATIONAL SAFETY AND HEALTH PROBLEMS IN THE FOOTWEAR INDUSTRY

Shoe-making is a labor-intensive process that involves a number of OSH hazards: noise, dust pollution, and injuries caused by presses and machines without double-handed safeguards (7). But most insidious of all are toxic organic solvents, particularly in adhesives, but also in the hardeners, cleaning solutions, and degreasers used in shoe-making. In Chinese shoe factories these solvents include benzene, toluene, xylene, methyl ethyl ketone, acetone, *n*-hexane, and methylene chloride. It should be noted here that because we could not conduct a systematic survey of all the adhesives used in Chinese footwear factories, there may be more toxic chemicals than these commonly known ones.

Of all the solvents listed above, benzene is the most dangerous. Acute benzene poisoning usually occurs in workplaces with poor ventilation. At high concentration, it can cause vertigo, headaches, and vomiting (Table 1) (8–27). In severe cases it can lead to a sudden loss of consciousness, respiratory and circulatory failure, and death (8). Ongoing skin or respiratory exposure to this chemical leads to chronic poisoning that damages the hematopoietic system, generates hyporegenerative anemia, and, in severe cases, leads to aplastic anemia. Benzene is carcinogenic, and chronic exposure has been associated with leukemia and other cancers (9). Prolonged or concentrated exposure to the other toxins used in

Table 1

Selected organic solvents used in footwear manufacturing and their health consequences

Solvent ^a	Acute health consequences	Chronic health consequence
Benzene (8–17)	Vertigo; headaches; nausea; vomiting; lost consciousness; respiratory and circulatory failure	Hyporegenerative anemia; aplastic anemia; leukemia; malignant lymphoma; lympho-hematopoietic malignancies; lung cancer; primary hepatocarcinoma; stomach cancer; nonneoplastic blood disease
Toluene (10, 18–20)	Vertigo; headaches; narcotic coma	Irritation of the mucous membrane; euphoria; headaches; vertigo; nausea; lost appetite; alcohol intolerance; autoimmune illness; reproductive disorders
Xylene (9, 20)	Vertigo; headaches; nausea; vomiting; lost consciousness; respiratory and circulatory failure	Fatigue; dizziness; headache; sleeplessness; irritability; memory and appetite loss; thirst; burning eyes; ringing ears; nose bleeds; nausea; vomiting; cardiovascular disease; liver, kidney, heart, neurosystem, and reproductive maladies
Methyl ethyl ketone (9, 21)	Irritation; headaches; nausea; vomiting	Dermatitis; peripheral neuropathy
Acetone (9)	Unrest; nausea; vomiting; progressive collapse; coma; kidney and liver damage	Headache; drowsiness; throat irritation; coughing; vertigo
<i>n</i> -Hexane (22–26)	Skin and mucous membrane irritation; dizziness; vertigo; convulsions; narcosis	Muscle paralysis
Methylene chloride (9, 27)	Lost appetite; headache; irritability; stupor; numbness; fatigue; unconsciousness; skin and eye irritation	Shortness of breath; pulmonary edema; liver damage

^aSource references in parentheses.

shoe-making can also be lethal. Acute poisoning by these solvents can produce symptoms akin to those resulting from acute benzene poisoning, and chronic exposure can generate a wide array of maladies in the skin, kidneys, liver, and muscles, as well as severe damage to the cardiovascular, neurological, immunological, and reproductive systems (Table 1) (8–27).

In industrialized countries, benzene is no longer used as a solvent for manufacturing adhesive glues (7, 9). In Italy, for instance, after two epidemics of aplastic anemia caused by benzene, this solvent was banned in 1965 by law, as pointed out to us by Neil Kearney, General Secretary of the International Textile, Garment & Leather Workers' Federation. Even in Taiwan, a newly industrialized country, a 1976 law prohibits the use of adhesives containing more than 5 percent benzene (28). Many other countries have reduced or are planning to reduce the permissible exposure limit (PEL) of benzene. In the United States, for example, the time-weighted average PEL was reduced from 10 ppm to 1 ppm in 1987, and the National Institute for Occupational Safety and Health is recommending a further reduction to 0.1 ppm (29).

Adhesives manufactured around the world contain different kinds and amounts of toxic solvents. The toxicity of the chemical compositions of these adhesives has been decreasing. A 1994 survey of glues used in footwear factories in northern Italy found that *n*-hexane, one of the most commonly used solvents, had been reduced to a much lower level than earlier (30). Our research in Taiwan and Australia indicates that a new generation of less toxic water-based adhesives is now being used experimentally in some factories. But because of their higher cost, the slower rate at which they dry, and the need for installing new machines, it will be some time before these adhesives become popularized in the footwear industry internationally.

Our field observations indicated that none of these technological improvements have yet been made in China. The most commonly used Chinese-made adhesives are toluene-based. This type of adhesive, even of the best quality, contains a small amount (5 percent or less) of benzene as an impurity. In fact, many of the toluene-based industrial products (including adhesives) produced in China contain about 10 percent benzene, with some as high as 20 to 30 percent (31). Consequently, according to a national survey, benzene was detected in the air of 76 percent of the workplaces using toluene- or xylene-based products (31), and it can reach high concentrations in poorly ventilated footwear factories.

There are preventive measures to reduce these harmful effects at the workplace. The most effective are reducing or eliminating the solvent vapor by localized exhaust ventilation at the source of vapor release; wearing protective clothing and gloves made of appropriate material or applying barrier creams; and donning respiratory masks with activated charcoal filters. Regular medical examination of workers to detect early signs and laboratory abnormalities resulting from exposure is also important (9). Unfortunately, during our factory visits in China we saw few of these preventive measures. It was unusual to see a

worker wearing any kind of mask, even ineffective cloth masks. A minority might be wearing gloves, but they tended to be made of cloth and so are not glue-proof. Many tens of thousands of workers are daily, in many cases for ten or more hours a day, inhaling and having direct skin contact with the toxins (32).

OCCUPATIONAL SAFETY AND HEALTH UNDER MAO

Under the political and economic system in place during the rule of Mao Zedong from 1949 to 1976, China faced serious OSH problems. For example, the world's largest study of benzene poisoning, covering 529,000 workers, was conducted from 1979 to 1981 in China. Of the ten benzene-related industries, footwear had the highest leukopenia prevalence rate, at 1.25 percent (33). One particularly relevant finding was that poisoning occurred when workers were exposed for a prolonged period, though only at less than 12.5 ppm (40 mg/m³), just slightly above the U.S. PEL (10 ppm) for benzene at that time (33). It was also discovered that the prevalence of aplastic anaemia was 5.8 times higher among footwear workers than the general population (34). In fact, some of the smaller, collectively owned footwear factories, not included in the above-mentioned large-scale surveys, were found to have more serious OSH problems (31). Thus the serious effects of benzene on workers' health were recognized in Chinese OSH circles at that time.

Fortunately, the OSH problems were taken more seriously by the Chinese government. The socialist ethos, aided by a centralized and regulated bureaucracy, was able to improve on the hazardous workplace conditions which prevail today under the economic reforms begun in the early 1980s. In the footwear industry, for example, workers' exposure to benzene had, in general, been reduced substantially by the mid-1970s (35). Furthermore, early large-scale surveys on the effects of benzene had revealed a dramatic decline of chronic benzene poisoning in workers, from a prevalence of 10.1 percent in the 1950s to 1.1 percent in the 1970s (33). The decline continued into 1984, when China's urban economic reforms began (35).

One factor that contributed to the decline in the prevalence of benzene poisoning in the Maoist era was the size of factories. At that time the industrial sector directly owned and operated by the central state was much bigger than the collective sector owned and managed by localities such as villages and towns. In 1980, on the eve of the economic reforms, there were 80 million state enterprise workers but only 24 million collective workers (the private sector had been out of existence since the mid-1950s) (36). State-owned factories tended to be large, often employing several thousand workers, and were therefore easier to monitor. State employees, hailed as pillars of the socialist state, also enjoyed much better social benefits, including OSH protection (37). In addition, by the mid-1970s less

toxic solvents such as toluene and xylene were beginning to replace benzene in some industries, including shoe-making (15).

OCCUPATIONAL SAFETY AND HEALTH UNDER “MARKET ECONOMICS IN COMMAND”

After Mao's death, with the advent of the industrial economic reforms during the early 1980s, the government encouraged collective and quasi-collective (read private) enterprises in the rural townships and villages to flourish, and welcomed foreign direct investment (38). As the centrally planned sectors of the economy continued to erode with economic and managerial decentralization, OSH deteriorated, as described later in this article. The central state and particularly the local governments are now driven by an economic imperative (39, 40)—thus our term “market economics in command,” with the profit motive overriding other concerns.

By the time we began visiting footwear factories in China in 1995, the bureaucracy in charge of leather, located in Beijing, which used to issue production quotas to all of the nation's footwear factories, had metamorphosed into an “association.” This has only vestigial connections with the still-surviving state-owned footwear factories. Its skeleton staff of less than ten has been reduced to holding trade exhibitions. Its head could not even attempt to give us a rough figure on the total number of shoe factories in the nation. Thousands of small factories have sprung up, especially in the coastal regions, while many of the state factories, which need to abide more closely to regulations and thus have higher production costs, have collapsed or are operating at greatly reduced capacity. From a central register lodged in Beijing we randomly selected ten state-owned footwear factories to visit in Chongqing City, but when we arrived in Chongqing two months later we discovered that all except two of these had closed down. Instead, a “shoe city” of dozens of small, privately owned factories has sprung up in the vicinity of the former big factories. In a village outside Shanghai that we visited, a large collectively owned shoe factory has proliferated into some 30 privately owned sweatshops. In less than two decades, China's footwear industry has been transformed—a much shrunken state sector and many more small factories. In 1989 there were less than 3,000 leather enterprises; by 1997 the number had exploded to 20,000 (41). The majority of the township- and village-owned enterprises and the domestic private enterprises produce mainly for the domestic market. Alongside these, a vast sector of foreign-funded factories that mainly produce for export has rapidly emerged, controlling about three-quarters of China's total export (42). Almost across the board, the OSH problems in the footwear industry, as described later, have been exacerbated. Even the state factories have begun violating China's OSH regulations, in a desperate effort to be more competitive. We discuss first the OSH conditions in factories funded by Chinese capital, and then conditions in foreign-funded enterprises.

Occupational Safety and Health Conditions in Factories Funded by Chinese Capital

A retrospective cohort study of 75,000 benzene-exposed state workers in 12 Chinese cities, conducted from 1987 to 1991 by the Institute of Occupational Medicine of the Chinese Academy of Preventive Medicine in collaboration with the U.S. National Cancer Institute (43), found that among 43 occupational groups that are exposed to benzene, the situation for three footwear-related tasks in particular (upper-shoe gluers, shoe polishers, and shoe glue grinders) began deteriorating in the mid-1980s (43). After a steady decrease in benzene exposure in the footwear occupation up to the early 1980s, increases in exposure were again being registered (35).

The study also uncovered details of the effects of benzene in relation to leukemia and hematolymphoproliferative disorders (43). Among the benzene-exposed workers, there were excess deaths for leukemia (with a relative risk (RR) of 2.3), malignant lymphoma (RR = 4.5), and neoplastic diseases of the blood (RR = infinite), and a significantly greater incidence of all lymphohematopoietic malignancies (RR = 2.6), malignant lymphoma (RR = 3.5), leukemia (RR = 2.6), aplastic anemia (RR = infinite), and myelodysplastic syndrome (RR = infinite) (11). To the extent that the smaller collectives and private enterprises, which were found to have worse OSH problems (44), were not included in the study, the problems for the entire industry must have been considerably worse than revealed in this survey. This can be illustrated through another study carried out by the Beijing Research Institute of Occupational Disease Control in Wenzhou, a "shoe city" in Zhejiang Province that is known nationally for its rapidly developing private sector (32). About 100,000 footwear workers in Wenzhou are exposed to benzene released from chloronorgutta, an adhesive that contains a high proportion of benzene. It was estimated in 1996 that some 5,000 to 6,000 of the Wenzhou workers were seriously afflicted. Workers in these private footwear factories largely labor in small, poorly ventilated sweatshops—64 percent of which were found to have benzene concentrations exceeding the permissible exposure limits—for 10 to 17 hours a day; for those who eat and sleep on the premises, 24 hours a day. Conditions are worst in winter when windows tend to be closed (32).

Though the use of adhesives containing pure benzene has declined in state enterprises in the past decades, this is not necessarily the case in the collective and private factories. News reports of benzene poisoning (e.g., 45–48) reveal that many workers in these factories are being exposed to benzene. The prevalent use of Chinese-manufactured adhesives containing high levels of benzene is partly related to cost. Our interviews with OSH officials and researchers at the Chinese Ministry of Labor revealed that benzene-based adhesives are about 30 percent cheaper than non-benzene-based adhesives. Moreover, not only are factory managers and owners, including trade union officials, often ignorant of the toxic effects of benzene; we also discovered a widely held myth among them that

benzene-based adhesives have a superior adhesive quality, a belief that our Australian interviewees who are specialists in the footwear industry dismissed as erroneous.

Occupational Safety and Health in Factories in Foreign-Funded Enterprises

Taiwan and Korea in the 1970s and 1980s had become the world's largest producers of shoes for the world export market, specializing in particular in brand-name sport shoes. By 1986 Taiwan was known as the world's "shoe kingdom," exporting 840 million pairs of shoes (49). As labor costs rose in the 1980s, these factories began to move off-shore to other Asian countries. By 1989 a massive relocation of Taiwanese shoe factories to mainland China had taken place. According to one estimate, 80 to 90 percent of China's footwear exports today are made by Taiwanese-owned factories (50). Two giant Taiwanese footwear companies, Pouchen and Feng Tay, have factories in several Asian countries, with the majority in China; the two firms together make 20 percent of the world's brand-name sports shoes (51).

Thus the OSH problems in China's foreign footwear factories are closely related to Taiwan's footwear industry and the attitudes and practices of Taiwanese management. The OSH conditions in Taiwan's footwear factories had left much to be desired before their exodus to China. Although by the 1980s Taiwanese adhesives were no longer benzene-based, they were hazardous nonetheless. Most of the adhesives manufactured in Taiwan for use by Taiwanese footwear factories were either toluene- or methyl ethyl ketone-based (70 percent toluene and 30 percent methyl ethyl ketone, or vice versa) (52). OSH enforcement of how these adhesives were handled was lax in Taiwan in the late 1980s on the part of both the manufacturers and the authorities. The hazardous effects of using the toluene- and methyl ethyl ketone-based solvents were confirmed by a 1988 study of 468 workers in 17 footwear factories in Taiwan. More than half of the sampled factories had not installed localized exhaust ventilation; and even for those that had, the capture velocity was insufficient. Although workers who came into contact with the organic solvents were provided with protective gloves, workers in only four factories wore them. Two of the 17 factories provided protective respirators, but none of the workers wore them. About half of the interviewed workers took naps at the workplace. About half of the female workers and one-third of the male workers had liver-function problems. These rates are significantly higher than those for the same age and gender cohorts (53).

Our visit in Taiwan in 1998 to three small shoe factories (workshops of less than 30 workers) that have not relocated to China indicated that these OSH problems are still very serious. Workers labored without masks or gloves. Large refrigerator-sized heaters without any attached exhaust facilities (used for heating the shoes after glue application) were sitting right in the middle of the workshop.

In one case, a worker was continuously dipping her bare hand into a tin of glue labeled with enormous Chinese characters "toluene." The owner/manager of this particular workshop was in the process of planning to relocate to China. These poor OSH conditions are likely to be transferred when the workshop is set up in China.¹

So, "technology transfer" from Taiwan to mainland China included transference of these irresponsible OSH practices. To ensure the adhesive quality of the glues used for their shoes, Taiwanese firms in China continue to obtain glues from Taiwan or from Taiwanese adhesive manufacturers that have moved to China. Most of the adhesives used in Taiwanese-funded enterprises accordingly are not benzene-based, unlike in the mainland's own domestically owned enterprises. Yet repeated reports of poisoning in these Taiwanese-funded enterprises (54–56), including benzene poisoning, indicate that a serious benzene problem persists.

The OSH problem in Taiwanese-funded enterprises caught the attention of the Beijing authorities in January 1996 only when an investigative report exposed that in the "shoe city" of Putian in Fujian Province, the health of 70,000 workers was being adversely affected. The levels of benzene, toluene, and xylene discharged into the atmosphere from some 150 foreign-owned shoe factories in the city were so high that the city's air was severely polluted, and even the health of residents in nearby neighborhoods was endangered (54). Fully 3,000 tons of toxic adhesives were being used in these factories each year, 80 percent of which was emitted into the atmosphere (54, 55).

Even before the 1996 exposé, reports of poisoning incidents in the city had appeared in the Chinese press. In 1993, for example, more than 20 workers at one factory were hospitalized for aplastic anemia caused by chronic benzene poisoning. Two of the workers were pregnant and died of leukemia (54). In Fuzhou, another city in Fujian Province, a worker died of acute poisoning after working in a shoe factory for only three months (56).

The most detailed OSH survey we have come across to date on a Taiwanese-run footwear factory looked at a joint venture located in Shanghai. The toluene concentration on the shopfloor where shoe bottoms were processed was 10.28 times the permissible limit; and on the shoe-upper shopfloor, six times the limit. The air movement velocity was 0.07 to 0.09 m/sec, though the minimum

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It should be noted, however, that based on our field visit in 1998, the two sports shoe giants, Pouchen and Feng Tay, which still manufacture a small number of shoes in Taiwan, have been switching to mainly water-based adhesives for about a year. Managers indicated they have become more conscious of the OSH problem following international consumer pressure. Compared with the small workshops, their shopfloors were better ventilated; warning signs on the hazards of various toxins were posted at all work stations; and most workers were wearing gloves and cloth masks (though the effectiveness of the latter is unknown). However, water-based adhesives are not completely free of toxic solvents. Rigorous research on the adhesives and on factory sites is still necessary to establish potential OSH problems.

allowable is 0.5 to 1.0 m/sec. All the windows of the factory were closed at night, and during work hours the extraction equipment did not function properly. Workers were suffering from dizziness, headaches, and insomnia, with chronic poisoning predicted to surface over time (57).

A puzzle that vexed us was why there is evidence of severe benzene poisoning in Taiwanese-owned factories that use toluene-based adhesives. From our interviews with the managers and workers of the Taiwanese footwear factories in China, we have discovered this is because of Taiwanese management's laxity in OSH matters. Even today the remaining footwear factories in Taiwan do not always use adhesives straight from the containers as they arrive from manufacturers. Factories tend to set aside a so-called "glue-mixing room" where adhesives from the suppliers are mixed with other chemicals. According to one of the two largest adhesive manufacturers in Taiwan whom we interviewed, the Taiwanese firms in China mix the adhesives they buy from Taiwan with mainland Chinese-made adhesives. Taiwanese investors report that they do so in order to cultivate a better relationship with the local authorities and with local manufacturers whose good graces are widely perceived as essential for the smooth running of their businesses. Toluene-based adhesives therefore become "contaminated" with benzene as many adhesives produced in China contain high levels of benzene (31). As mentioned previously, mainland-owned Chinese footwear factories buy these benzene-based adhesives because they are 30 percent cheaper than non-benzene-based ones. For these sweatshop operations every cent of savings counts. In contrast, the Taiwanese investors who mix in these benzene-based adhesives are not driven by a profit motive, since, as pointed out by an Australian adhesive supplier whom we interviewed, the cost of adhesives constitutes less than 1 percent of total production costs.

THE ROLE OF THE STATE IN OCCUPATIONAL SAFETY AND HEALTH

Under any sociopolitical system, power within the management-worker relationship is almost invariably tipped toward management, and the same applies in the existing socialist workers' states (39). In modern economies, the state addresses this imbalance by setting up OSH standards to protect workers' health, by ensuring enforcement of such standards, and, when the standards are violated, by ensuring adequate medical coverage and compensation for the victims. The standards of permissible exposure limits set by governments reflect a state's commitment to protecting workers' health.

Most of China's current PELs were developed by 1979 (58) when OSH protection measures were taken more seriously (Table 2) (59-68). Thus China's current PELs for toluene, xylene, and acetone are on a par with or more stringent than those of countries with developed capitalist economies.

Table 2
Permissible exposure limits of solvents in footwear industry in various countries^a

Solvents	China (59, 60) ^b	U.S. (29, 64) ^c	Taiwan (61-63) ^d	Australia (65)	Europe (66, 67) ^e	Former USSR (68)
Benzene	1958: 25 ppm (80 mg/m ³)	1941: 100 ppm	1974: 25 ppm	5 ppm (16 mg/m ³)	1995: 1 ppm	1980s: 1.57 ppm (5 mg/m ³)
	1962: 19 ppm	1947: 50 ppm	1985: 10 ppm			
	(60 mg/m ³)	1948: 35 ppm	1995: 5 ppm (16 mg/m ³)			
	Since 1979:	1957: 25 ppm				
	12.5 ppm (40 mg/m ³)	1969: 10 ppm				
	1971: 10 ppm					
	1987: 1 ppm					
Toluene	26.6 ppm (100 mg/m ³)	Since 1978: 200 ppm	Since 1974: 100 ppm	100 ppm (376 mg/m ³)		
Xylene	23 ppm (100 mg/m ³)	Since 1978: 200 ppm (870 mg/m ³)	Since 1974: 100 ppm (435 mg/m ³)	80 ppm		

Methyl ethyl ketone	Not regulated	200 ppm (590 mg/m ³)	200 ppm (590 mg/m ³)	150 ppm (445 mg/m ³)
Acetone	168 ppm (400 mg/m ³)	1,000 ppm (2,400 mg/m ³)	750 ppm (1,780 mg/m ³)	500 ppm (1,185 mg/m ³)
n-Hexane	Not regulated	500 ppm	50 ppm (176 mg/m ³)	50 ppm (174 mg/m ³)
Methylene chloride	Not regulated	25 ppm	50 ppm	50 ppm (174 mg/m ³)

^aSource references in parentheses.

^b1958 and 1962 benzene (59), 1979 all chemicals (60).

^cBenzene (29); all other chemicals (64).

^d1974 and 1985 benzene (61, 62); 1995 all chemicals (63).

^eEconomic and Social Committee, EEC.

There are problems with China's PELs, though. Because so many were developed in 1979 (59) before market reform was in full swing and have not been revised since, despite rapid industrialization under the economic reforms, two major OSH problems have arisen. First, while other countries, based on new research on toxicity, have set lower PELs for some of the chemicals we are concerned with here, China's PELs have become outdated. Benzene is a case in point. Up until 1979, China's PEL for benzene was lower than that of the United States while Taiwan's was higher (Table 2), but since then all of the countries listed in Table 2—the United States, Taiwan, Australia, the European Union, and the former USSR—have set lower limits. Second, China still has not set PELs for some chemicals that previously were rarely present but now are quite prevalent in workplaces. Thus chemicals such as methyl ethyl ketone, *n*-hexane, and methylene chloride, commonly present in the adhesives widely used in the foreign-run footwear firms in China, are not regulated (60). Footwear workers in China therefore have practically no legal protection against exposure to these solvents.

No significant new evidence has been found on the health effects of toluene, xylene, and acetone over the past two decades. As a result, the PELs for these solvents in the United States, Taiwan, and Australia have remained unchanged since the 1970s. China's PELs for these three solvents, set in 1979, are clearly much more stringent than those set by these other countries (Table 2), but enforcement is a big problem. Under China's economic reforms, as noted, economic endeavors have been decentralized to local governments, and in turn to the enterprises. The proliferation of non-state footwear factories compounds the problem of OSH enforcement. In fact, there is widespread collusion between foreign investors and the Chinese local governments that are supposed to oversee them (69). These local governments are often partners in the foreign joint ventures or, if not, are still heavily dependent on the tax revenues and fees they generate (69). Putian City's top local officials openly admitted when grilled by a Chinese reporter that they had not and would not enforce OSH standards in the foreign-run footwear firms for fear of driving away investments (54). Not surprisingly, when we visited Putian six months after the severe poisoning of workers that had been nationally publicized, the city trade union official in charge of OSH told us that only two of 150 foreign-funded firms had installed more effective extraction equipment since the scandal, while the rest had refused to comply.

In such cities, local OSH authorities and environmental protection agencies find themselves at the very bottom of the bureaucratic totem pole. Even if they have the best of intentions, these bureaucracies lack the staff, the resources, the authority, and sufficient support from above to carry out their duties. Indeed, OSH officials face active obstruction from local governments (54). In a big city like Shanghai, where we interviewed five state OSH officials in 1995, all that the OSH agencies' staff can hope for, as several of them all but admitted to us, is that under urban renewal, all factories, including footwear, will soon be relocated to suburban areas—out of sight, out of mind. The problem is particularly acute in

the so-called new “shoe cities,” most of which only a decade ago were farmland. Combined, they contain thousands of large and small footwear factories, variously owned by local governments, private entrepreneurs, or foreign companies. The majority of the workers are migrants from poor rural areas who job-hop from factory to factory. For example, in the “shoe city” of Dongguan, in 1986 only 22.4 percent of workers were migrants; in 1990 it was 87.4 percent (70). Very often, by the time the symptoms of workers’ health problems appear these workers have left the factory, and it becomes impossible to trace which factory has been most responsible for the problems. A report conducted by a county government in Hunan Province on 600 peasants who had returned home after working in urban factories found that 11 percent of them had contracted occupational diseases (71).

China does not stand alone in any of these problems. They are prevalent also in neighboring Vietnam, in Indonesia, and in other Asian countries that manufacture footwear. In fact, one of the worst cases known to us of toxicity in an Asian footwear factory relates to a Korean-owned Nike subcontractor in Vietnam that hires 10,000 workers (72). It was built only in 1995 and is one of the most technologically advanced of all Nike plants. But according to Nike’s own internal investigation conducted in October 1996 (73), workers wore no protective equipment in a work environment where the lax Vietnamese PEL standard for toluene (26.6 ppm or 100 mg/m³) (74) was exceeded by six times or more in different sections of the plant. The level of acetone in the air was 6 to 18 times the Vietnamese PEL (84 ppm or 200 mg/m³). Medical check-ups of 165 workers in three of the factory’s sections revealed that 77.5 percent of them had respiratory diseases, and “an increasing number of employees,” according to the report, suffered from skin, heart, and throat diseases (72, 73).

CONCLUSION

This problem of toxic solvents is affecting hundreds of thousands of Chinese and other Asian workers. The situation seems likely to deteriorate as labor-intensive industries in China and elsewhere in Asia and the world become more competitive. As yet, OSH problems in the footwear industry are not being given due emphasis within these countries—or even by those international organizations that are concerned with the workers’ well-being, such as the nongovernmental organizations that participate in the Apparel Industry Partnership. The toxic effects on footwear workers in the third world and particularly in China, by far the largest manufacturer of footwear in the world, are severe and need to be addressed.

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REFERENCES

1. Blustein, P. Apparel industry reaches agreement to end sweatshops in U.S. and abroad. *New York Times*, April 9, 1997.
2. *White House Fact Sheet on Apparel Code of Conduct*. U.S. Information Service Washington File, April 14, 1997.
3. Light, J. *Sweatwash: The Apparel Industry's Efforts to Co-opt Human Rights*, December 1998. Available from <http://www.coprwatch.org/trac/greenwash/sweatwash.html>.
4. Apparel Industry Partnership. *Preliminary Agreement, Charter Document, Fair Labor Association*, November 1998, p. 19. Available from <http://www.lchr.org/sweatshop/aipfull.htm>.
5. *Reuters*, Beijing, August 15, 1996.
6. *UN COMTRADE International Trade Data*, May 1997.
7. Stellman, J. M. (ed.) *Encyclopaedia of Occupational Health and Safety*, Ed. 4. International Labor Office, Geneva, 1997.
8. Yin, S., and Li, Q. The prevention of benzene poisoning (in Chinese). *Science and Technology of Labor Protection* 1: 36–38, 1982.
9. Parmeggiani, L. (tech. ed.). *Encyclopaedia of Occupational Health and Safety*, Ed. 3. International Labor Office, Geneva, 1983.
10. Yin, S., et al. Symptoms and signs of workers exposed to benzene, toluene or the combination (in Chinese). *Ind. Health* 25: 113–130, 1987.
11. Yin, S., et al. A cohort study of cancer among benzene-exposed workers in China: Overall results. *Am. J. Ind. Med.* 29: 227–235, 1996.
12. Yin, S., et al. Cohort study among workers exposed to benzene in China: I. General methods and resources. *Am. J. Ind. Med.* 26: 383–400, 1994.
13. Paci, E., et al. Aplastic anemia, leukemia and other cancer mortality in a cohort of shoe workers exposed to benzene. *Scand. J. Work Environ. Health* 15(5): 313–318, 1989.
14. Walker, J. T., et al. Mortality of workers employed in shoe manufacturing. *Scand. J. Work Environ. Health* 19: 89–95, 1993.
15. Yin, S., and Li, G. Benzene risk and its prevention in China. In *The Identification and Control of Environmental and Occupational Disease*, Vol. 23, edited by M. A. Mehlman and A. Upton. Princeton Scientific Publishing, Princeton, N.J., 1994.
16. Yin, S., et al. Leukemia in benzene workers: A retrospective cohort. 44: 124–128, 1987.
17. Yin, S., et al. A retrospective cohort study of leukemia and other cancers in benzene workers. *Environ. Health Perspect.* 82: 207, 1989.
18. Wang, Y., et al. Aromatics (in Chinese). In *Modern Occupational Medicine*, Chapt. 13. People's Medical Publishing House, Beijing, 1996.
19. Kovaergik, J., et al. Neurologic findings in persons exposed to toluene for long periods. *Ceskoslovenska Neurologie a Neurochirurgie* 48/81(2): 73–77, 1985.

20. Fishbein, L. An overview of environmental and toxicological aspects of aromatic hydrocarbons, II. Toluene. *Science of the Total Environment* 42: 267–288, 1985.
21. Dyro, F. M. Methyl ethyl ketone polyneuropathy in shoe factory workers. *Clin. Toxicol.* 13(3): 371–376, 1978.
22. Abbritti, G., et al. Shoe-makers' polyneuropathy in Italy: The aetiological problem. *Br. J. Ind. Med.* 33(2): 92–99, 1976.
23. Bartolucci, G. B., et al. Polyneuropathy in the shoe industry: An experimental, aetiological and clinical contribution (in Italian). *Securitas* 63(3–4): 187–206, 1978.
24. D'Andrea, F., et al. Vestibular changes in shoe manufacturing workers (in Italian). *Medicina del lavoro* 70(1): 16–20, 1979.
25. Rossi, L., et al. Value of haematochemical indicators in the prevention of glue polyneuropathy (in Italian). *Rivista di medicina del lavoro ed igiene industriale, Suppl.* 2: 97–111, 1978.
26. Brugnone, F., and Perbellini, L. Solvent pollution at workplaces in shoe and shoe upper factories. *Medicina del lavoro* 71(4): 343–352, 1980.
27. Zeng, C. *Occupational Medicine Principles and Practical Applications*, Ed. 2. Yearbook Medical Publishing, Chicago, 1988.
28. Ministry of Interior Affairs. *Document on Labor* (in Chinese), No. 659306. Taiwan, March 16, 1976.
29. Graham, J. D., Green, L. C., and Roberts, M. J. *In Search of Safety: Chemical and Cancer Risk*, p. 91. Harvard University Press, Cambridge, Mass., 1988.
30. Agnesi, R., Valentini, F., and Dal Vecchio, L. Fall in *n*-hexane exposure risk in the shoe manufacturing industry. *Medicina del lavoro* 85(4): 309–313, 1994.
31. Yin, S., et al. The explanation of the development of the diagnostic criteria and management principle for occupational benzene poisonings (in Chinese). In *Toxicological and Epidemiological Studies on Benzene in China*, edited by S. N. Yin and G. Li. Institute of Occupational Medicine, Chinese Academy of Preventive Medicine, Beijing, 1994.
32. Liu, R. Alert: The occupational hazards in village and township enterprises (in Chinese). *Women's Daily*, January 29, 1996.
33. Yin, S. N., et al. Occupational exposure to benzene in China. *Br. J. Ind. Med.* 44: 192–195, 1987.
34. Yin, S. N., et al. A survey of benzene aplastic anemia in a shoe-making factory (in Chinese). *Science and Technology of Labor Protection* 960(6): 14–21, 1986.
35. Dosemeci, M., et al. Cohort study among workers as exposed to benzene in China: II. Exposure assessment. *Am. J. Ind. Med.* 26: 401–411, 1994.
36. *China's Statistical Yearbooks* (in Chinese). Beijing, 1989.
37. Wong, L., and MacPherson, S. (eds.). *Social Change and Social Policy in Contemporary China*. Avebury Publishing, Aldershot, England, 1995.
38. Qu, T., and Green, M. B. *Chinese Foreign Direct Investment*, pp. 47–69. Ashgate Publishing, Aldershot, England, 1997.
39. Zhao, M. H., and Nichols, T. Management control of labour in state-owned enterprises: Cases from the textile industry. *China J.* 36: 1–21, 1996.
40. Freund, E. M. Downsizing China's state industrial enterprises: The case of Baoshan steel works. In *Adjusting to Capitalism: Chinese Workers and the State*, edited by G. O'Leary, pp. 101–121. M. E. Sharpe, Armonk, N.Y., 1998.

41. Gao, W. Leather industry requires retooling. *China Daily*, March 17, 1997, p. 5.
42. Kahn, J. Foreigners help Chinese boost trade surplus. *Asian Wall Street Journal*, July 15, 1997.
43. Yin, S. N., et al. Cohort study among workers exposed to benzene in China: II. Exposure assessments. *Am. J. Ind. Med.* 26: 383–400, 1994.
44. Xu, Y. Urgency in coping with OSH hazards in township and village enterprises (in Chinese). *J. Labor Med.* 15(1): 62–63, 1998.
45. Chu, P. There are various perspectives on workers' benzene-poisoning cases (in Chinese). *Workers' Daily*, June 24, 1995.
46. Yi, W. Who can defend the seven workers? (in Chinese). *Workers' Daily*, November 11, 1995.
47. Chang, J. Shift workers: Hidden occupational disease prevalent (in Chinese). *Chinese Women's Daily*, January 3, 1996, p. 2.
48. Chi, C. The occupational disease should not be ignored in China (in Chinese). *Shin Daily*, November 8, 1994.
49. Chen, J. P. Footwear industry (in Chinese). In *The Republic of China Industrial Development 1995 Yearbook*, pp. 791–803. ROC Ministry of Economics, Bureau of Industry, Taipei, 1996.
50. Cheng, L. L. *Embedded Competitiveness: Taiwan's Shifting Role in International Footwear Sourcing Networks*. UMI Dissertation Services, Ann Arbor, Mich., 1996.
51. Exposing the secret of how Pouchen became the king of the world's shoe industry (in Chinese). *Today's Weekly* (Jin zhoukan), June 29, 1997, pp. 78–81.
52. Chao, J. R. The Study of the Relationship between Occupational Problems and Productivity (in Chinese), pp. 29–31. Master's thesis, Graduate Institute of Industrial Engineering, National Ching Hua University, Taiwan, 1985.
53. Lin, Y. C. *The Study of Footwear Workers' Exposure to Organic Solvents* (in Chinese). Research Report for the Labor Committee of the Republic of China Executive Ministry. Taipei, Taiwan, 1988.
54. Chen, Y. Special report on the rights and interests of women workers in foreign enterprises (in Chinese). *Chinese Women*, January 15–17, 1996.
55. Chung, M. Putian footwear industry is reputed in the world; the fumes from the three-hydrocarbons fill both the inside and outside of the factories (in Chinese). *Overseas Chinese News*, September 10, 1994.
56. Female died of poisoning: Joint venture factory pays out 100,000 yuan compensation (in Chinese). *Cheng News*, October 23, 1996.
57. Lai, S. S., et al. An OSH survey of a certain foreign-funded footwear enterprise (in Chinese). *Labor Medicine* 14(2): 93, 1997.
58. Cai, C. Selections of labor safety and health standard (in Chinese). In *Collections of the Labor Safety and Health Laws in China*, edited by C. Cai, pp. 1359–1415. Xinhua Press, Beijing, 1995.
59. Ministry of Public Health. *The Health Standard for Industries and Enterprises Design*, TJ 36–79 (in Chinese). Beijing, 1980.
60. Cai, C. Workplace health, selections of labor safety and health standard (in Chinese). In *Collections of the Labor Safety and Health Laws in China*, edited by C. Cai, pp. 1363–1365. Xin Hua Press, Beijing, 1995.

61. The Labor Bureau. *The Ministry of Interior Affairs, Taiwan* (in Chinese). Administrative Order No. 58463. Taiwan, August 7, 1974.
62. The Labor Bureau. *The Ministry of Interior Affairs, Taiwan* (in Chinese). Administrative Order No. 302043. Taiwan, April 15, 1985.
63. Labor Committee, Administrative Yuan. *Collections of Workers' Safety and Health Laws and Regulations* (in Chinese). Labor Safety and Health Book Series, Labor Committee, Administrative Yuan, Taipei, 1997.
64. National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Public Health Service, U.S. Department of Health and Human Services. *NIOSH Pocket Guide to Chemical Hazards*. U.S. Government Printing Office, Washington, D.C., 1994.
65. Occupational Health, Safety and Welfare Commission of Western Australia. *Exposure Standards for Atmospheric Contaminants in the Workplace in Western Australia*. Western Australia, 1991.
66. European Community Commission. Proposal for a council directive amending for the first time directive 90/394/EEC on the protection of workers from the risks related to exposure to carcinogens at work. *Official Journal of Council Directive*, No. C 317. Brussels, 1995.
67. Economic and Social Committee. Opinion of the Economic and Social Committee on the proposal for a council directive amending for the first time directive 90/394/EEC. *Official Journal of Council Directive*, No. C 097. Brussels, 1996.
68. Wang, Y., and Gang, B. (eds.). Occupational cancer (in Chinese). In *Contemporary Labor Health Science*, Chapt. 7. People's Health Press, Beijing, 1994.
69. Hsing, Y. T. A new pattern of foreign direct investment: Taiwanese guerilla investors and local Chinese bureaucrats in the Pearl River Delta (in Chinese). *Taiwan: A Radical Quarterly in Social Studies* 23: 159–182, 1996.
70. Li, C. Surplus rural labourers and internal migration in China. In *Migration in China*, edited by B. Bakken, p. 36. Nordic Institute of Asian Studies, Copenhagen, 1998.
71. Shek, P. K. China's labor safety and health standards. *Exchange*, June 1997, p. 3.
72. Greenhouse, S. Nike shoe plant in Vietnam is called unsafe for workers. *New York Times*. November 8, 1997, front page.
73. Ernst & Young environmental and labor practice audit of the Tae Kwang Vina Industrial Ltd. Co., Vietnam, 1997. Available from <http://www.corpwatch.org/trac/nike/audit.html>.
74. The Office for Labor Hygiene. *Report on the Investigation and Measurement of Climate and Hazards: Samyang Vietnam Co., Cu Chi District*. Ho Chi Minh City, Vietnam, 1996.

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