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# PROCESSING RISK PROFILES IN THE ITALIAN TEXTILE INDUSTRY: AN ASSESSMENT OF OCCUPATIONAL ACCIDENTS

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## INTRODUCTION

The textile processing industry is a very wide sector, consisting in a series of work stages, aimed at the processing of raw materials (natural, artificial or synthetic fibres), for the manufacturing of products, with various properties and characteristics.

In the last decades, then, the sphere of the utilization of textile products has been considerably extended to innovative applications, ranging from medical and surgical to pharmaceutical, cosmetic and anti-pollution fields, alongside the classical sectors of clothing and furnishing. We can also observe that the textiles utilized in these latter applications are made not only from new synthetic polymers but also from natural fibres, such as wool or silk, properly modified (1). In any case, every activity or productive cycle of textile industry is made up by a battery of work phases, with particular exposures and potential hazards for workers. At the same time, however, some risk factors are common to every work profile of the sector.

The following data intend to present a descriptive picture of the harm to workers' health in the Italian textile industry. The authors draw from more informative sources, available at national level, to provide an exhaustive enough description of the textile industry and of the risks due to the working conditions in this sector.

The accident phenomena have been described in the light of the structural features of the sector that, in Italy, is formed by a high number of small and medium sized enterprises (SMEs), with particularly high concentrations in certain geographical areas.

People employed in the textile industry constitute 8.2% of all industrial workers, thus making up the 4$^{th}$ sector, in relation to the number of employees. Workers then carrying out manual or non-clerical activities account for 70% of employees, compared to the manufacturing industry's 61%. The average textile firm size (6 employees) (ref: Table 1) is larger than the manufacturing industry average (4,6 employees).

**Table 1. Textiles & Garment Manufacture: Structural Features, 1996**

| Economic activity | Local units | employees | % employees | Mean size (empl/local unit.) | % workers | % clerical |
|---|---|---|---|---|---|---|
| Manufacture of textiles | 40491 | 308122 | 4,3 | 7,6 | 71% | 29% |
| Manufacture of wearing apparel/garments | 58487 | 284011 | 4,0 | 4,9 | 68% | 32% |
| **TEXTILES & GARMENT MANUFACTURE.** | **98978** | **592133** | **8,2** | **6,0** | **70%** | **30%** |
| | | | | | | |
| **INDUSTRY** | 1552732 | 7181157 | 100,0 | 4,6 | 61% | 39% |

Source: ISPESL

Geographically, textile industry employees (74,2% of total industry employees) are essentially grouped in just five regions of the twenty that make up the country (see: figure 1). Of these five regions, the enterprises in Emilia-Romagna and Toscana are medium-small in size, with just over 4 employees per production facility or local unit, below the national average (6 employees) (see: figure 2).

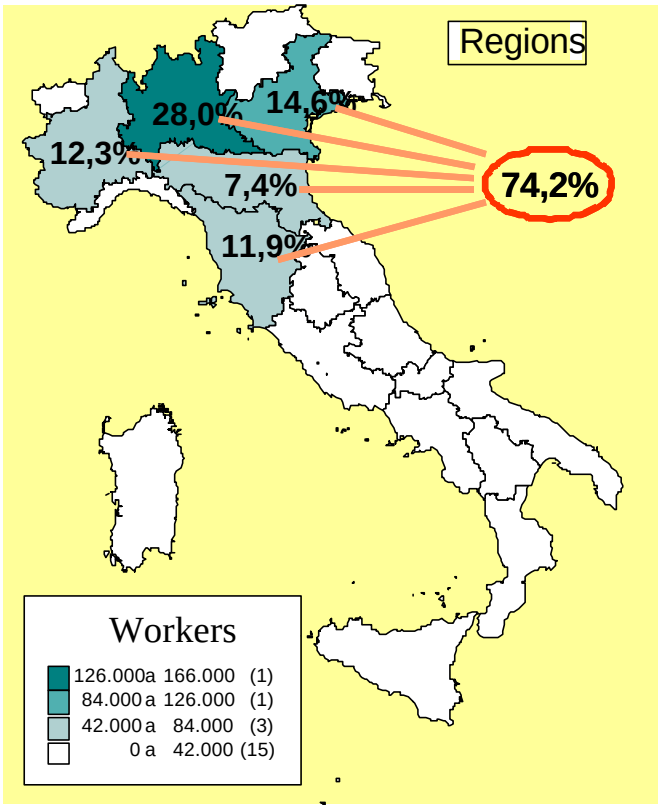


Fig. 1: National distribution of textile workers by Region

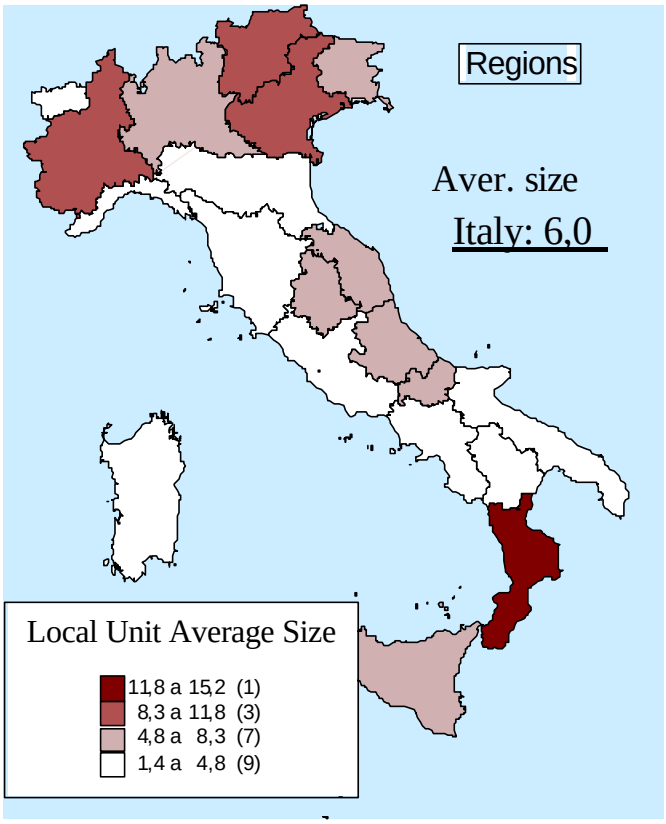


Fig. 2: Average size of local units by Region

## METHODOLOGY

For statistical analysis purposes, appropriate indicators were employed to synthesize the data relating to workplace accidents drawn from INAIL (National Institute of Insurance Against Accidents at Work), for years 1995-1999, and ISPESL (National Institute for Prevention and Safety at Work), for years 1996-1997 (2-4).

In order to calculate the accident risk indicators, employee data was drawn from ISPESL's National Register of Workplaces (1996), the only source in Italy, which differentiates within the manufacturing

industry between “worker” and “administrative employee”. Within the context of this paper, the term “worker/s” refers to those employees who carry out mainly manual or non-clerical activities. Note that this employee group is involved in almost all accidents (98%) occurring in the manufacturing industry. Focusing on this number allows the calculation of indicators, which indicate the category of workers actually exposed to accident risks. The worker data, like all other Workplace Register data, is generated by data base record linkages with other administrative agencies, such as pension management and local Chamber of Commerce enterprise membership data.

The frequency rates have been calculated considering the mean number of accidents that occurred in the three-year period 1995-1997 as the numerator. The three-year average was used to compensate for yearly fluctuations and to allow a more significant comparison to be made between the indicators.

With reference to other indicators used in this paper, the Concise Severity Index (CSI) simultaneously accounts for actual working days lost, due to injuries causing temporary disablement, and conventional working days lost, due to fatal injuries and permanent disablement [1]. The “days of absence” from work are referred only to injuries causing temporary disablement.

The description of textile industry accidents was performed using variables contained in the INAIL database, which records all accidents resulting in the payment of compensation or annuities. More specifically two variable pairs were employed:(Nature/Site of lesion) and (Form/Agent). The former pair to analyse the physical consequences of the injury and the latter to briefly describe how the accident came about.

Data used in this paper regard different databases, so data showed inside tables are referred to different years because they are collected in different periods of time. Moreover, the reader has to consider that data can be affected from the underreporting problem, specially for the accidents that involve only slight consequences and for the quality of the coding of original accident reporting forms: a common problem of information drawn from insurance systems.

Detailed information, at qualitative level, about some important production cycles, “card spinning”, “fabric dyeing/printing” and “garment fashioning”, have been taken from ISPESL’s “Sector Risk Profiles” National Database (5).

This database lists risk information with relation to each individual stage of a production cycle, as directly observed in a group of firms located in the territory belonging to a Local Sanitary Unit (LSU). These LSU are selected on the basis of diffusion of the investigated activity in its competence area.

The following are available for each risk profile: a production cycle flow chart, a document covering the sector as a whole and a document dedicated to each individual work stage. The description of each individual stage is, with few exceptions, reported within the following eight chapters: Work stage; Equipment, Machinery, Plant Systems; Risk Factors; Expected Harm; Suggested Intervention; Third-party Contracting; Legislative References; Environmental Risk. At present, this database is made up by 60 sectorial risk profiles.

**Results**

In terms of accident risks, the analysis of the manufacturing industry accident indicators (ref: Table 2) shows that textile industry activities are among the least risky, well below the overall manufacturing industry average. Textiles ranks among the manufacturing industry’s least risky sectors even if fatal accidents are targeted. On a national basis, some regions show a higher accident risk (ref: Table 3). Focusing upon the five regions where the sector’s activity is highest, and on Toscana specifically, note that the Region’s risk index (67,37 accidents/1000 workers/annum) is decidedly higher than the national average (47,16 accidents/1000 workers/annum).

[1] Temporary disablement: actual working days lost
Permanent disablement: conventional working days lost = percent degree of permanent disablement * 7500
Fatal accident: 7500 conventional working days lost (300 days *25 years of working life)

**Table 2. Industry: frequency rate according to economic activity and outcome. Average of 1995-97 triennium (by 1000 workers)**

| ECONOMIC ACTIVITY | Total accident rate | Fatal accident rate |
|---|---|---|
| 10 Mining of coal and lignite; extraction of peat | 1,83 | 0,00 |
| 11 Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction, excluding surveying | 32,91 | 0,00 |
| 13 Mining of metal ores | 178,47 | 0,00 |
| 14 Other mining and quarrying | 103,42 | 0,56 |
| 15 Manufacture of food products and beverages | 73,71 | 0,09 |
| 16 Manufacture of tobacco products | 41,43 | 0,00 |
| 17 Manufacture of textiles | 47,15 | 0,04 |
| 18 Manufacture of wearing apparel; dressing and dyeing of fur | 17,96 | 0,03 |
| 19 Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear | 32,12 | 0,03 |
| 20 Manufacture of wood and of products of wood and cork, except furniture; Manufacture of articles of straw and plaiting materials | 152,99 | 0,15 |
| 21 Manufacture of paper and paper products | 91,58 | 0,12 |
| 22 Publishing, printing and reproduction of recorded media | 39,34 | 0,02 |
| 23 Manufacture of coke, refined petroleum products and nuclear fuel | 42,58 | 0,03 |
| 24 Manufacture of chemicals and chemical products | 63,51 | 0,15 |
| 25 Manufacture of rubber and plastic products | 83,04 | 0,11 |
| 26 Manufacture of other non-metallic mineral products | 108,33 | 0,18 |
| 27 Manufacture of basic metals | 140,97 | 0,15 |
| 28 Manufacture of fabricated metal products, except machinery and equipment | 112,60 | 0,14 |
| 29 Manufacture of machinery and equipment NEC (not elsewhere classified) | 102,54 | 0,09 |
| 30 Manufacture of office, accounting and computing machinery | 29,31 | 0,21 |
| 31 Manufacture of electrical machinery and apparatus NEC | 60,72 | 0,07 |
| 32 Manufacture of radio, television and communication equipment and apparatus | 56,55 | 0,11 |
| 33 Manufacture of medical, precision and optical instruments, watches and clocks | 36,69 | 0,06 |
| 34 Manufacture of motor vehicles, trailers and semi-trailers | 80,08 | 0,04 |
| 35 Manufacture of other transport equipment | 106,08 | 0,10 |
| 36 Manufacture of furniture; manufacturing NEC | 80,54 | 0,07 |
| 37 Recycling | 151,93 | 0,57 |
| 40 Electricity, gas, steam and hot-water supply | 58,36 | 0,16 |
| 41 Collection, purification and distribution of water | 113,10 | 0,09 |
| 45 Construction | 132,19 | 0,41 |
| INDUSTRY | 88,35 | 0,15 |

Source: ISPESL

**Table 3: Textile Industry: National accident frequency rate by Region. 1995-1997 three-year mean.**

| REGION | Frequency rate (/1000 workers) | accidents/year (95-97mean) |
|---|---|---|
| PIEMONTE | 49,68 | 1652,3 |
| VALLE D'AOSTA | 27,78 | 0,3 |
| LOMBARDIA | 43,9 | 4282,3 |
| TRENTINO-ALTO ADIGE | 49,43 | 134,3 |
| VENETO | 39,46 | 1381,7 |
| FRIULI-VENEZIA GIULIA | 100,34 | 338,3 |
| LIGURIA | 50,04 | 18,7 |
| EMILIA-ROMAGNA | 34,83 | 551,7 |
| TOSCANA | 67,37 | 2445,0 |
| UMBRIA | 31,35 | 125,0 |
| MARCHE | 34,61 | 122,3 |
| LAZIO | 49,82 | 117,7 |
| ABRUZZI | 31,37 | 183,7 |
| MOLISE | 64,2 | 8,7 |
| CAMPANIA | 33,83 | 107,0 |
| PUGLIA | 27,15 | 148,7 |
| BASILICATA | 91,08 | 48,0 |
| CALABRIA | 83,86 | 52,7 |
| SICILIA | 25,72 | 26,3 |
| SARDEGNA | 100,75 | 130,7 |
| **ITALY** | 47,15 | 11875,3 |

Source: ISPESL

The textile and garment manufacturing sectors (identified according to INAIL's fee code classification) show a decrease in total accidents over the past few years. The trend of the accident risk index, however, has remained substantially constant between 1996 and 1999 (see: figure 3), due to the decrease of insured workers in these two sectors, as a result of employment cutbacks.

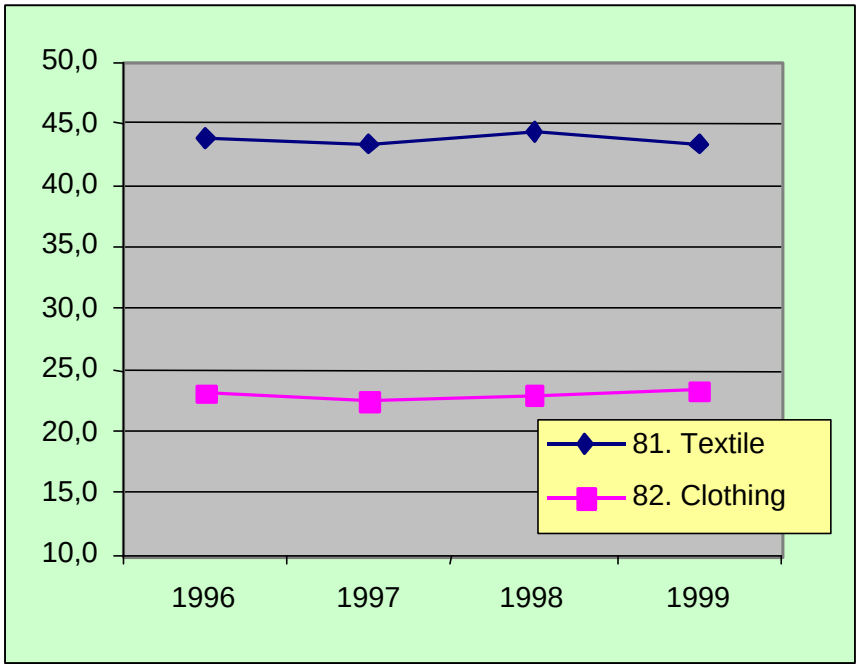


Figure 3: Textile and garment manufacturing frequency index trend.

Using the INAIL accident database variables, it is possible to use the pair "Nature/Site of lesion" to analyse the physical consequences of the accidents. In textiles and garment manufacturing, the largest number of accidents involve Cuts and Bruises (ref: Table 4) especially to the hands and the head.

**Table 4: Textiles & Garment Manufacture Injuries: Nature and Lesion Site distribution. Reference year: 1999**

| Nature of lesion | Head | Upper body, internal organs | Spinal column | Spinal chord | Upper limbs | Hand | Lower limb | Foot | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| Cuts | 720 | 29 | . | . | 413 | 4.516 | 279 | 100 | 6.057 |
| Bruises | 870 | 727 | 369 | 13 | 837 | 2.027 | 1.217 | 751 | 6.811 |
| Luxation/Sprain/Twist | 59 | 267 | 1.432 | 43 | 411 | 420 | 1.263 | 141 | 4.036 |
| Fractures | 88 | 206 | 93 | 7 | 323 | 806 | 224 | 414 | 2.161 |
| Anatomical amputation | . | 1 | . | . | 2 | 110 | 1 | 1 | 115 |
| Lesions caused by parasitic and infectious agents | 4 | 3 | . | . | 2 | 3 | 2 | 1 | 15 |
| Lesions caused by other agents (heat, electric energy,...) | 226 | 39 | . | . | 129 | 187 | 58 | 49 | 688 |
| Foreign objects | 268 | 8 | . | 1 | 9 | 194 | 10 | 2 | 492 |
| Strain-induced lesions | 1 | 26 | 212 | 12 | 33 | 10 | 20 | 1 | 315 |
| TOTAL | 2.236 | 1.306 | 2.106 | 76 | 2.159 | 8.273 | 3.074 | 1.460 | 20.690 |

Source: INAIL

Reading across the Table, it is evident the number of injuries to the vertebral column, caused by spraining/twisting and strain-related lesions. The hands are the most affected lesion sites also in terms of severity, showing numerous cases of anatomical loss.

The Form/Agent variable pair allows us to describe in a concise manner how the accident came about. Available data clearly illustrates the role played by work-related/en-route road accidents (ref: Table 5), close to the top of the list, which ranks according to the lesions' *CSI* of the variable pair "Form/Agent". This is however common to a number of other sectors as well. An important role in textiles is played by Falls at work, which result in long periods of absence from work, ranked just behind absences resulting from accidents occurring aboard transport vehicles. Lastly the variable pair "lift/moving of solid materials", which relates to the physical consequences on the spinal column injuries mentioned previously. Note that the top 15 Form/Agent variable pairs ranked according to the *CSI* account for 40% of all textile industry accidents.

**Table 5: Textile Industry: accident Form /Agent pairs ranked in decreasing Concise Severity Index (CSI) order. Reference year: 1997**

| Way of occurrence and Material agent | Total accidents | % accidents | CSI | Days of absence |
|---|---|---|---|---|
| ACCIDENT DRIVING A... ROAD TRANSPORTATION | 619 | 5,3 | 146.059 | 33,4 |
| FALLEN, ON A FLAT SURFACE, ON... TRANSIT SURFACES | 488 | 4,2 | 46.070 | 26,8 |
| ACCIDENT ON BOARD OF... ROAD TRANSPORTATION | 79 | 0,7 | 30.866 | 35,7 |
| CRUSHED BY... OPERATING MACHINES | 199 | 1,7 | 27.847 | 23,4 |
| FALLEN FROM HEIGHT LADDERS AND FOOTPATHS | 148 | 1,3 | 24.634 | 28,5 |
| SLIPPING ON TRANSIT SURFACES | 383 | 3,3 | 21.853 | 22,9 |
| HIT BY... MECHANIC PARTS OF MACHINES | 375 | 3,2 | 20.828 | 20,7 |
| HITTING ONESELF WITH... MECHANIC PARTS OF MACHINES | 285 | 2,5 | 20.417 | 15,5 |
| GOT STRUCK BY... OPERATING MACHINES | 104 | 0,9 | 19.330 | 26,5 |
| HITTING ONESELF WITH... OPERATING MACHINES | 145 | 1,3 | 19.189 | 18,7 |
| KNOCKING ONESELF AGAINST... MECHANIC PARTS OF MACHINES | 302 | 2,6 | 18.981 | 18,3 |
| CRUSHED BY... MECHANIC PARTS OF MACHINES | 220 | 1,9 | 16.363 | 25,4 |
| KNOCKING ONESELF AGAINST... OPERATING MACHINES | 516 | 4,4 | 16.200 | 18,6 |
| HIT BY... SOLID MATERIALS | 357 | 3,1 | 14.143 | 17,7 |
| LIFTING WITH NO STRAIN... SOLID MATERIALS | 210 | 1,8 | 14.122 | 19,9 |
| KNOCKING ONESELF AGAINST... SOLID MATERIALS | 273 | 2,4 | 13.189 | 17,7 |
| Total | 4703 | 40,4 | | |

Source: ISPESL

The process breakdown of 1999 accident data shows that a number of events took place in the fashioning of fabrics, hides and garments (4906 accidents), weaving (4538 accidents), while a proportionally lower number took place in spinning, twisting and doubling (2442 accidents) and yarn finishing (2205 accidents), fewer still in the textile fibre preparation (241 accidents) and complete textile fibre processing (251 accidents). The breakdown reflects the number of operators employed in each process. What is more interesting is the percentage of severe injuries, i.e. those which resulted in fatalities or permanent incapacitation. In fact, the percentage allows to suitably comparing the various types of hazards peculiar to each process. In that respect, severe injuries were highest in fibre preparation (7,1%), followed by complete textile fibre processing (4,4%), fashioning of fabrics, hides and garments (3,3%), with the remainder of the processes accounting for approximately 2,6%.

For an in depth analysis of occupational accidents and with the aim to evaluate the conditions for lowering the although low, but still present in the Italian textile industry, accident risk, we have examined in detail 3 important production cycles, present in the ISPESL's "Sectoral Risk Profiles" National Database: spinning of the card, fabric dyeing/ printing and garment fashioning.

Spinning of the card is a broad and complex process that includes various phases such as blend preparation, spinning and the maintenance-cleaning-inspection of spinning and carding machines. All these activities involve a high risk of severe injuries. The above process phases open the fibres and prepare them for subsequent processing and involve the utilization of large, complex machinery with sharp edges, moving parts and components under electrical tension. During these operations, oily substances are employed both for machinery lubrication and fibre cleaning.

An analysis of the sector's injury data shows that accidents are due to the proximity of operators to the machinery. The circumstances may cause lesions and bruises caused by snatching and dragging by the machinery's moving parts, fatal electrical shocks, crushing

of hands and feet, cuts. Note also that preparing the fibres for carding operations generates dust, which may cause eye and skin irritation and respiratory problems as well as exposure to irritating and toxic substances, such as mineral oils and glycols.

The second risk profile deals with fabric dyeing and printing and includes all those process phases which start with the materials supplied by the spinning mills and lead to the finished product ready for the fashioning phases. It is a highly skilled process with some differences due to the type of fibre being processed (e.g. silk, cotton, synthetic fibres). In general terms, a distinction may be drawn between superior grade yarns, such as silk, which entails a labour-intensive low-automation processing of limited quantities of material at low working speeds and ordinary yarns, such as cotton and synthetics, which entail large volumes of materials processed, using more advanced technology and automation.

In the former case the risk factors are principally connected to the uncomfortable working postures and to the exposure to irritating and toxic substances. The latter case shows greater accident risks, including contact with caustic substances. Accident causes may be traced to pressure-operated machinery, operator proximity to high-speed machines (moving at up to 80 metre/min.), and the high concentration of natural gas heated plants. Lesions and injuries are caused by snatching and grabbing by moving parts, crushing and dragging, cuts and burns caused during fibre preparation and carbon monoxide intoxication during finishing operations.

The last profile concerns garment fashioning (clothing), generally considered a low accident risk activity, as it has evolved into a highly fragmented process, involving the shifting of certain production cycle phases to non-European Union member countries and the elimination of specific repetitive and uncomfortable tasks. Activities eminently carried out nationally include marketing/design/fashioning of sample collection garments, often computer-assisted and automated, as well as quality control of garments acquired abroad, warehousing and distribution.

However this risk profile indicates the occurrence of numerous, and at times, severe injuries. The most frequent hazards seem mainly to be the inappropriate posture forced upon machinery operators (e.g. long standing periods during fabric control, cutting and pressing operations), repetitive tasks, proximity to machinery with moving components, exposure to dusts and aerosol pollutants (e.g. stain removal, cutting and pressing operations), exposure to radiant heat and uncomfortable work micro-climate. Vertical storage shelves and elevated workstations are used throughout the sector and they cause injuries from falls and overturned loads.

Accident consequences thus relate to traumatic lesions caused by falls and shocks, crushing and burns to the upper limbs during the pressing phase, traumatic lesions from falls during warehousing, cuts to the hands and fingers with possible amputation during the cutting phases. Non-ergonomically correct work postures and load moving are generally held responsible for muscular-skeletal ailments and, when occurring in women, also of miscarriages and premature births. Note that the workforce in this area is prevailingly female.

## CONCLUSIONS

The Italian textile industry, which has always represented an important sector of Italian economy, has undergone important structural and organisational changes during recent decades, especially as regards the production process fragmentation and the transfer of numerous production phases to non-national entities. A marked improvement has been experienced nationally, concerning worker exposure to toxic substances,

especially carcinogens and agents harmful to reproduction (1). However, with respect to safety, no relevant changes have occurred except that computers and automation have been introduced in certain process steps such as the design, printing and cutting. This may explain the substantially constant trend of the already low accident index (Fig. 3), measured in the reference period (1996-1999). Other studies in Italy confirm the low risk level of the textile industry. A study of 1259 cases of fatal injury which occurred in Lombardia Region during the period 1984-1989 ranks textile and garment industry jobs 8$^{th}$ (2.9%), with the building construction industry (25.3%) and agriculture (17.2%) first and second, respectively (6).

The textile industry's production sectors, nevertheless, still present a high percentage of severe injuries, such as the loss of a hand, which occur frequently during the fibre preparation phase. Hand injuries represent a long-standing industry problem not only in Italy. Myles and Roberts, e.g., reported in detail on 41 cases of hand injuries to Yorkshire wool industry workers, in the period 1965-1984 (7). Certain hazards, then, previously considered to be absent from the sector, such as blood-borne infections (hepatitis B and C, HIV), transmitted through the use of devices fitted with hollow needles, have been reported too (8).

Ongoing issues, however, concern the use of machines with high speed moving parts, manual hauling and storage of heavy loads, ergonomically unsound workstations. In textiles and garment manufacturing, then, a huge number of accidents involve cuts and bruises (ref: Table 4), especially to the hands and the head.

The above suggests that it is not sufficient to protect workers using a combination of personal protection equipments and safety guards fitted to the most hazardous machinery, but should be minutely analysed the wide-ranging working conditions of local enterprises, with special regard to SMEs.

In Italy, the high number of SMEs is a common trait to numerous productive sectors. SMEs, on the average, show a higher risk factor than that displayed by the larger production units, presumably due to the greater difficulties encountered with respect to technology innovation and employee professional update (2), both of which are basic elements for an efficient and safe organization of work.

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