ORIGINAL ARTICLE

Are regulations effective in reducing construction injuries? An analysis of the Italian context

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ABSTRACT

Objectives At the end of the 1990s, as required by European Directive 92/57/EEC, two laws were enacted in Italy which laid down safety and health requirements for construction sites: Decree 494/96 and Decree 528/99. The aim is to evaluate the impact on injury rates due to actions performed by a group of eight regions that planned formalised programmes to enforce the laws around the year 2000.

Methods Using the Work History Italian Panel-Salute integrated database, which extends from 1994 to 2005, total and serious injury rates were calculated for the construction sector. An interrupted time series analysis was applied to serious injury rates.

Results During the 12 years under observation, at the national level the total and serious injury rates decreased while the number of employees increased. The results of the regression models indicate that in the period after the intervention the injury rates (×10 000 weeks worked) decreased by 0.21 per year more than in the period before the intervention (CI −0.41 to −0.01). The difference in pre-post trends is even larger after adjusting for external factors.

Conclusions The intervention plans developed to enforce the two Italian decrees had an effect on the reduction in injury rates. The results showed that there was a decrease in injury rates that could not be explained by external factors. These findings highlight the importance of concrete initiatives to have employers and workers comply with regulatory safety standards.

What this paper adds

- The construction industry is characterised by complex and different job tasks, workforce skills, climatic conditions and work environments, and an inadequate organization can result in a high incidence of work-related injuries.
- The law alone is not effective in reducing fatal and non-fatal injuries in the construction industry and additional strategies are needed to have employers and workers comply with regulatory safety standards.
- Various prevention programs have been proposed in the field of construction, but their effectiveness evaluation is limited: this is the first time in Italy that the health impact of a law concerning occupational safety and health has been evaluated.
- Appropriate changes to the organizational and prevention system reduce employee injury rates.
- Concrete strategies in enforcing national laws are necessary to improve safety in the construction industry: all policies should be systematically accompanied by formalised evaluation plans.

INTRODUCTION

Effective interventions and laws to prevent occupational injuries are necessary to improve workers' safety, but even if various prevention programmes have been proposed in the field of construction, evaluation of their effectiveness is limited.[1 2] The Cochrane Collaboration has published a review which aims to evaluate interventions designed to reduce occupational injuries among construction workers.[3] One of the main conclusions is that the law alone is not effective in reducing fatal and non-fatal injuries in the construction industry, and additional strategies are needed to have employers and workers comply with regulatory safety standards. The need is also stressed for studies that incorporate valid statistical analysis to establish the effect of various safety interventions in the construction industry.

The construction industry is characterised by different, complex job tasks, workforce skills, climatic conditions and work environments.[4] A number of different trades are typically present on site simultaneously and tasks are often performed in close proximity, potentially creating hazards for nearby labourers.[5] Workers are also frequently hired under temporary employment contracts and the practice of subcontracting is widespread.[6] In addition to these factors, the varied and changeable nature of the construction industry, the lack of a controlled working environment and the different sizes of the organisations, all have an effect on safety performance within the industry.[7] The work location for any group of workers often changes, and each work site evolves as construction proceeds, changing the hazards workers face week by week and sometimes even day to day.[8]

This is the context that the occupational health and safety policies had to tackle, and this is why the European Union decided to enact a specific directive to regulate safety in the construction industry: Directive 92/57/EEC.[9] This law laid down minimum safety and health requirements for temporary or mobile construction sites and led to the promulgation of Legislative Decree 494/96 in Italy.

The main innovations established by this reform concern the role of the owner and of two new figures, the coordinator for the project and the coordinator for the execution. The coordinators

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have to draw up the safety coordination plan in two phases, while the owner has to set up a separate operating safety plan. The conceived safety system is based on the belief that most of the injuries that occur on site are the result of not dealing with the problem of safety before starting work and that a third of all fatal injuries occur because of interference from different work activities that take place simultaneously or subsequently.[10]

In November 1999 a new version of the Italian law was enacted, Legislative Decree 528/99, basically with the aim of solving some critical problems which complicated the enforcement of the previous law, and defining in detail the role of the safety and coordination plan.

The Italian public system of prevention has fielded a number of initiatives in order to strengthen the laws' enforcement. The effectiveness of these activities in preventing injuries has never been established even though the construction industry still remains a priority for research and intervention at the national and international levels.[1 5 10 11]

The aim of this study is to evaluate the impact on injury rates of the intervention plans developed to enforce the two Italian decrees relating to the construction industry.

MATERIALS AND METHODS

Data sources

The Work History Italian Panel (WHIP)-Salute integrated database is a longitudinal surveillance system based on record linkage of routine data coming from INPS (Italian National Social Security Institute) and INAIL (Italian Workers' Compensation Authority). The database, which extends from 1985 to 2005, is described in detail elsewhere[12]: here we summarise only the most important features.

The WHIP was built starting from a sample of workers extracted from INPS: the workers were selected every year, from 1985 to 2005, on the basis of the day of birth (sampling fraction of 1 : 15). About 5.9 million dependent work episodes were extracted. The employment history was reconstructed for each person sampled, including all employment periods, retirement and any period in which the individual received social security benefits such as unemployment subsidies. The sample is representative of the private sector (manufacturing, construction, services) and does not cover public employment and agriculture. The most extensive and complete archive regarding dependent workers contains, in addition to demographical data, various information on jobs and companies. Information regarding self-employed workers is not yet available in the database.

The injuries occurring between 1994 and 2005 were extracted from the INAIL database with the same sampling frame. All reported injuries that were recognised as due to occupation with more than 3 days of absence from work were linked to the WHIP archive using an encrypted version of the Italian tax code.

For the purpose of this study, all male workers employed in the construction industry between 1994 and 2005 were selected, and commuting accidents were excluded.

Study framework

Legislative Decrees 494/96 and 528/99 are both national laws; nevertheless the enforcement strategies were not uniform in different areas of Italy. By examining the published documentation and interviewing regional representatives for health and safety at work, a group of eight regions was defined which planned formalised programmes around the year 2000 and here will be referred to as *early intervention regions*. These programmes mainly concerned inspections, training and information plans and were characterised by the high degree of coordination of initiatives at the local level. By focusing the analysis on this area, it is possible to highlight the potential effect of the reforms. On the other hand, a group of 10 regions started the enforcement strategies after the year 2005, herein called *late intervention regions* (figure 1). These two groups together represent 97% of construction workers in 2005: the early intervention group represents 62% and the other group 35%. The remaining two regions were left out because it was not possible to assess whether they activated any specific initiatives in the years between 2000 and 2005.

In Italy, the mobility of workers in the construction industry is very high, and workers can also move from one region to another. Since in the database the information was available on the region where the individual worked, the worker was classified according to the workplace and not the region of the company offices.

The entry of a law into force is not always contingent upon its enactment. In particular, the kinds of regulations being studied take quite a long time to be enforced, often requiring the adoption of implementing decrees. Some critical issues made the application of Decree 494/96 difficult at the starting point. Thus, a unique breakpoint can be considered after the enforcement of Decree 528/99, in the year 2000. In the analyses, this last single time interruption will then be taken into account and the overall effectiveness of the interventions related to the two laws will be evaluated.

Statistical analysis

Total and serious yearly injury rates (per 10 000 weeks worked) were calculated from 1994 to 2005. The denominator was corrected considering part-time work and a discount factor calculated as the ratio of the periods of illness and temporary lay-off to the total weeks. Serious injuries include deaths, injuries involving permanent disability or more than 30 days of absence from work. Rates were calculated at the national level and separately for the two groups of regions. To compare early and late intervention regions, injury rates were directly standardised by age (<25; 25–34; 35–44; 45–54; >54 years), nationality (Italian vs foreigner) and company size (<10; 10–49; 50–249; >250 employees) using a mean reference population.[13] The 95% CIs were calculated using the normal approximation to the Poisson distribution.[14]

Following the guidelines of 'The Cochrane Collaboration' an interrupted time series analysis (ITS) was performed to assess the effect of the interventions.[3] The ITS approach is based on the use of regression models for time series, called segmented regression models, which take into account secular trends and correct any autocorrelation between the single observations. This correction is necessary to avoid biased estimates of SEs. A first order autoregressive model was defined using the following parameterisation[15]:

$$Y_t = \beta_0 + \beta_1 \times \text{time}_t + \beta_2 \times \text{intervention}_t + \beta_3 \times \text{time after intervention}_t + e_t$$

where $e_t = \rho_1 e_{t-1} + v_t$, $v_t \sim N(0, \sigma^2)$

Here Y_t is the crude serious injury rate of early intervention regions in year t; time is a continuous variable indicating time in years at time t from the start of the observation period; intervention is an indicator for time t occurring before (intervention=0) or after (intervention=1) the interruption; time after intervention is a continuous variable counting the number of years after the intervention at time t.

Figure 1 Italy: early and late intervention regions.

This analysis focused on serious injury rates because the literature suggests that this measure is less correlated to macroeconomic factors than minor injury rates[16] and is less affected by under-reporting.[17]

A second model was defined using standardised serious injury rates of early intervention regions as a response variable and adding the standardised serious injury rates of late intervention regions as a covariate. Including late intervention regions' rates in the model provides some level of adjustment for external factors, which can influence the injury rates trend.

Statistical analyses were performed mostly using STATA V.10. The dstdize command was used to standardise the rates. The Prais-Winsten and Cochrane-Orcutt regressions were used to specify the autoregressive model. The same results were found using proc autoreg with SAS V.9.1.

RESULTS

During the 12 years of study, the number of employees in the sample under observation has grown notably and the number of weeks worked has increased from around 2 million in 1994 to over 3 million in 2005. At the same time, the rates of total and serious injuries decreased and the ratio between serious and total injuries dropped (table 1).

Standardised serious injury rates for early and late intervention regions are presented in table 2. Early intervention regions have lower rates compared with those of late intervention regions, even before the enactment of the laws.

Figure 2 shows the decreasing trend of crude serious injury rates in early intervention regions starting from the point of interruption. The ITS model estimated four coefficients. The first one ($\hat{\beta}_0$) represents the baseline level at time zero, the second ($\hat{\beta}_1$) represents the preintervention trend, the third ($\hat{\beta}_2$) estimates the level change immediately after the intervention, and the last one ($\hat{\beta}_3$) estimates the change in the trend from before to after the break. Assuming a gradual onset and a permanent duration intervention structure, the element of interest is the change in the trend from before to after the interruption, not so much the change in the level.[18]

The results of the interrupted time series analyses are presented in table 3. The estimated coefficients of the first model, which has the crude rates as a response variable, indicate a significant difference between the preintervention and postintervention slopes in early intervention regions ($\hat{\beta}_3 = -0.208$, CI −0.41 to −0.01), that is, injury rates fell faster in the last period. The results of the second model, which is applied to the standardised crude rate of early intervention regions and adjusted for the standardised crude rate of late intervention regions, are consistent with those of the previous one. The difference found between the preintervention trend and the postintervention trend is even larger and more significant ($\hat{\beta}_3 = -0.423$, CI −0.61 to −0.24).

DISCUSSION

In the last decades there has been a global decreasing tendency in construction injury rates[19 20] as well as in all other industrial sectors. Improvements in industrial practices and in technology, increasing standardisation and automation of processes and

Table 1 Distribution of workers, weeks worked and total and serious injury rates (×10000 weeks) per year; Italy, 1994–2005, construction industry, employees, male

Year	Workers	Weeks worked	Total injuries	Total injury rate (CI 95%)	Serious injuries	Serious injury rate (CI 95%)
1994	78409	2204638	4989	22.63 (22.00 to 23.26)	1318	5.98 (5.66 to 6.30)
1995	75653	2055124	4493	21.86 (21.22 to 22.50)	1227	5.97 (5.64 to 6.30)
1996	74734	1987541	4568	21.47 (20.80 to 22.14)	1038	5.66 (5.34 to 5.98)
1997	69303	1935310	4000	20.67 (20.03 to 21.31)	1075	5.36 (5.03 to 5.69)
1998	70192	1961291	3978	20.28 (19.65 to 20.91)	1075	5.48 (5.15 to 5.81)
1999	76187	2114398	4266	20.17 (19.56 to 20.78)	1197	5.66 (5.34 to 5.98)
2000	83264	2394097	4681	19.55 (18.88 to 20.11)	1365	5.70 (5.40 to 6.00)
2001	87291	2481570	4740	19.10 (18.56 to 19.64)	1405	5.66 (5.36 to 5.96)
2002	99003	2705005	4910	18.15 (17.64 to 18.66)	1423	5.26 (4.99 to 5.53)
2003	101670	2992186	5186	17.33 (16.86 to 17.80)	1529	5.11 (4.85 to 5.37)
2004	104408	3164830	5278	16.68 (16.23 to 17.13)	1616	5.11 (4.86 to 5.36)
2005	104418	3124487	4999	15.99 (15.55 to 16.43)	1591	5.09 (4.84 to 5.34)

Table 2 Distribution of serious injuries and standardised serious injury rates (×10000 weeks) per year in early intervention and late intervention regions; 1994–2005, construction industry, employees, male

	Early intervention regions		Late intervention regions	
Year	Serious injuries	Standardised serious injury rate (95% CI)	Serious injuries	Standardised serious injury rate (95% CI)
1994	744	4.81 (4.41 to 5.20)	498	6.94 (6.32 to 7.57)
1995	702	5.08 (4.63 to 5.52)	459	7.25 (6.56 to 7.94)
1996	656	4.40 (4.05 to 4.74)	411	7.44 (6.70 to 8.18)
1997	636	4.74 (4.43 to 5.13)	350	7.10 (6.33 to 7.87)
1998	653	5.15 (4.71 to 5.58)	349	7.15 (6.32 to 7.97)
1999	723	5.46 (5.04 to 5.88)	402	6.81 (6.10 to 7.52)
2000	811	5.17 (4.82 to 5.53)	397	6.29 (5.65 to 6.94)
2001	768	4.86 (4.52 to 5.20)	491	7.49 (6.81 to 8.17)
2002	771	4.12 (3.82 to 4.42)	484	6.88 (6.27 to 7.49)
2003	836	4.18 (3.87 to 4.48)	487	6.59 (6.01 to 7.18)
2004	914	4.24 (3.94 to 4.53)	485	5.86 (5.34 to 6.38)
2005	866	4.15 (3.86 to 4.45)	482	5.86 (5.34 to 6.39)

general efforts to identify and eliminate hazards led to safer workplaces,[21] and may have had a favourable effect on injury occurrence.[22] On the other hand, higher education and better training of workers led to improvements in the quality of the workforce.[23] This decrease is also evident in our data and table 1 shows that even before the regulations, the total injury rates trend was descending.

ITS is a suitable method for evaluating the interventions taking into consideration this spontaneous dynamic. In fact the counterfactual is calculated on the basis of the situation observed before the intervention. The results of the analysis applied to the crude rates (Model I) show that early intervention regions (which had planned formalised inspection programmes as a consequence of the enactment of the regulations) had a greater reduction in serious injury rates in the postintervention period compared with the previous one. The identified trend is not peculiar to some regions, but it is a shared process (data not shown).

The difference in the trends is also confirmed after controlling for the effect of external influences (Model II).

Besides secular trends, variations due to contemporary economic cycles need to be considered. Studies on the relationship between business cycles and the risk of injury showed a positive correlation between the evolution of main macroeconomic indicators and the rate of injury: during periods of economic expansion the rate increases, while in periods of recession the rate falls.[24 25] The construction industry is particularly sensitive to fluctuations.[26] The most important factors are summarised below.

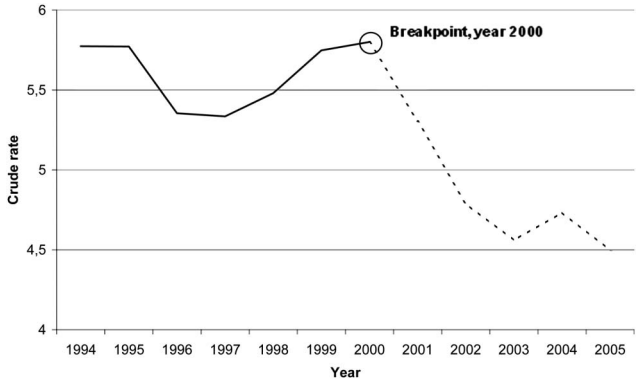

Figure 2 Early intervention regions' crude serious injury rate (×10 000 weeks); 1994–2005, construction industry, male.

Total injury rates are positively linked to the gross domestic product, the number of new workers and the intensity of the work, and are negatively related to unemployment. In particular, construction injuries are positively related to the number of building permits.[27] On the other hand, serious injury rates are less affected by the gross domestic product and the unemployment rate, even though they are linked with the recruitment of new workers, the percentage of small companies and the ratio of the hours actually worked in respect to the usual number.[16]

Using the rates of serious injuries limits at least the problem of under-reporting, which can be more relevant during periods of high unemployment: workers may decide not to report minor injuries in order to reduce their risk of dismissal.[16]

Nevertheless, as the macroeconomic trend may confound the relationship between intervention and injury rate, some level of adjustment was taken into account in Model II.

In order to ascertain the economic tendency in the construction industry over the years examined, employment and value added at basic price trends (used as a proxy for production in the construction sector) were taken from ISTAT (National Institute of Statistics). The data, detailed according to economic activity and region, was available from 1995 to 2005. These indicators may be positively related to injury rates. Separate time series were constructed for the early and late intervention regions (data not shown): the trends were the same, although the levels were different. Specifically the trend was steady until 1999 and later it began to grow. This growth, combined with the decline in the overall unemployment rates observed for this period, should have led to an increase in injury rates and therefore cannot explain the decrease observed in early intervention regions.

Late intervention regions' injury rates are influenced by a similar economic trend and also by other possible unmeasured factors. Therefore, they were included as a covariate in the model to adjust overall for external factors. The standardised rates were used because of the very different workforce composition between two groups for some variables (ie, nationality).

Some studies report a greater risk for immigrant workers than for native ones, generally due to: difficulty in understanding the

Table 3 Results of interrupted time series analyses

	Model I (crude rates)		Model II (adjusted rates)	
	Estimate	95% CI	Estimate	95% CI
$\hat{\beta}_0$ (baseline level)	5.695	5.25 to 6.14	9.131	5.80 to 12.45
$\hat{\beta}_1$ (preintervention trend)	−0.031	−0.17 to 0.11	0.062	−0.08 to 0.21
$\hat{\beta}_2$ (level change)	0.285	−0.31 to 0.88	0.261	−0.48 to 1.00
$\hat{\beta}_3$ (trend change)	−0.208	−0.41 to −0.01	−0.423	−0.61 to −0.24

language, more dangerous and precarious jobs, and inadequate training.[28 29] Other studies limit these risk differences to the frequency and severity of injuries, stressing that they are present only in certain subgroups of individuals.[30 31] Since the 1990s Italy has become a major destination for work migration, and in recent years the incidence of entries for dependent work reasons has increased greatly. The evolution of the phenomenon from 2000 onwards showed a gap between the southern regions, which support the growth of the number of Italian employees, and those of the North, whose growth is driven mainly by foreign workers. Between 2000 and 2008, there was an average annual percentage increase of 12.2% in the number of foreign employees for the central and northern regions, and 9.6% for the southern regions.[32] A more detailed analysis of activity reveals other differences by geographical area: in the Centre-North more than 40% of foreigners are involved in industry and construction, while foreign occupation in the South is mainly concentrated in agriculture, hospitality and catering, retail trade and household services.[33] The increase of foreigners, even in this case, could have led to an increase in injury rates that contrasts with the actual decrease.

The results of Model II show that controlling for the effect of external influences the change in the trend is confirmed: in the postintervention period injury rates decreased more than in the preintervention period.

In addition to these features it should be noted that in the years under observation there were no changes in recordkeeping regulations that could have led to a decline in rates.[34]

One of the main strengths of this study concerns the quality of the data available. Injury rates derived from the WHIP-Salute database are very accurate because the data is at the individual level in the entire period of study. The unit of measurement for the person-time is down to weeks worked per month, and the information on part-time conditions and the periods of absence allow the denominator to be further refined. Another strength regards the methodology used. The segmented regression analysis is the method recommended by Cochrane to study the interrupted time series, which are considered better than the classic pre-post design used in many papers. In addition, compared with other examples, the data is available for several years and this provides an adequate pre and post period. This technique does not require a control group to be applied as the counterfactual is reconstructed on the basis of the temporal segment before the intervention.

An important limitation of the present study is the lack of comprehensive data on self-employed workers. However, this cannot bias the results because the proportion was stable during the period under study (about 40% of the construction workforce). Nevertheless, to study this category of workers is crucial because they tend to take on the most dangerous jobs. A database including complete information is under development and will be analysed in the future.

CONCLUSIONS

The regulations formed by Decree 494/96 and Decree 528/99 and the subsequent actions, if appropriately implemented, may lead to lower injury rates. The results of this study show that indeed there was an improvement in injury rates that cannot be explained by external factors. If other European countries evaluated the effectiveness of their national laws, a term of comparison would be available to better understand the magnitude of the effects found.

The improvement seen in early intervention regions, although slight, highlights the importance of concrete initiatives in enforcing these types of laws. The need to implement a formalised supervision plan has also been the subject of the national prevention plan for the construction industry 2009–2010, which focused on the issue of surveillance on construction sites as a tool to control the implementation of regulations. The aim of that plan was to render uniform the entire Italian territory, in such a way that all regions apply the same procedures and interventions.

To confirm the results that these first analyses provided it is useful to continue the study including a balanced control group with which to make comparisons. Using a propensity score matched sample should allow the effectiveness of the interventions to be assessed in terms of the frequency and timing of injuries.

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Contributors EF performed all the statistical analyses and wrote the paper. AB was the main supervisor of the project, with expertise in the field of occupational injuries. She read and commented on the analyses and the manuscript. OP gave advice on the methodological choices, read and commented on the paper. GC read and commented on the paper. Each author is confident of the validity of this work, has reviewed the final version of the manuscript and approves it for submission.

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REFERENCES

1 Lethola MM, van der Molen HF, Lappalainen J, *et al*. The effectiveness of intervention for preventing injuries in the construction industry. *Am J Prev Med* 2008;35:77–85.
2 Lipscomb HJ, Li L, Dement J. Work-related among union carpenters in Washington state before and after the vertical fall arrest standard. *Am J Ind Med* 2003;44:157–65.
3 van der Molen HF, Lehtola MM, Lappalainen J, *et al*. Interventions for preventing injuries in the construction industry. *Cochrane Database Syst Rev* 2007;17;4: CD006251.
4 Cattledge GH, Hendricks S, Stanevich R. Fatal occupational falls in the U.S. construction industry, 1980–1989. *Accid Anal Prev* 1996;28:647–54.
5 Lipscomb HJ, Glazner JE, Bondy J, *et al*. Injuries from slips and trips in construction. *Appl Ergon* 2006;37:267–74.
6 Bena A, Berchialla P, Debernardi ML, *et al*. Impact of organization on occupational injury risk: evidence from high-speed railway construction. *Am J Ind Med* 2011;54:428–37.

7 Sawacha E, Naoum S, Fong D. Factors affecting safety performance on construction sites. *Int J Proj Manag* 1999;17:309–15.
8 McDonald MA, Lipscomb HJ, Bondy J, *et al*. '"Safety is everyone's job': The key to safety on a large university construction site. *J Saf Res* 2009;40:53–61.
9 Aires MD Martinez, Gamez CR, Gibb A. Prevention through design: the effect of European directives on construction workplace accidents. *Saf Sci* 2010;48:248–58.
10 Haslam RA, Hide SA, Gibb AGF, *et al*. Contributing factors in construction accidents. *Appl Erg* 2005;36:401–15.
11 Darragh AR, Stallones L, Bigelow PL, *et al*. Effectiveness of the HomeSafe Pilot Program in reducing injury rates among residential construction workers, 1994–1998. *Am J Ind Med* 2004;45:210–17.
12 Bena A, Leombruni R, Giraudo M, *et al*. A new Italian surveillance system for occupational injuries: characteristics and initial results. *Am J Ind Med* 2012;55:584–92.
13 Clayton D, Hills M. *Statistical models in epidemiology*. New York: Oxford University Press, 1993:136–8.
14 Rosner B. *Fundamentals of biostatistics*. 7th edn. Boston: Brooks/Cole, Cengage Learning, 2010:729.
15 Wagner AK, Soumerai SB, Zhang F, *et al*. Segmented regression analysis of interrupted time series studies in medication use research. *J Clin Pharm Ther* 2002;27:199–309.
16 Davies R, Jones P, Nuñez I. The impact of the business cycle on occupational injuries in the UK. *Soc Sci Med* 2009;69:178–82.
17 Mendeloff J, Burns R. States with low non-fatal injury rates have high fatality rates and vice-versa. *Am J Ind Med* 2012. doi:10.1002/ajim.22047.
18 Yafee R, McGee M. *Introduction to time series analysis and forecasting: with applications of SAS and SPSS*. Orlando, FL: Academic Press, Inc, 2000:272–6.
19 Bailer AJ, Stayner LT, Stout Na, *et al*. Trends in rates of occupational fatal injuries in the United States (1983–92). *Occup Environ Med* 1998;55:485–9.
20 Fabiano B, Currò F, Patorino R. Occupational injuries in Italy: risk factors and long term trend (1951–98). *Occup Environ Med* 2001;58:330–8.
21 Conway H, Svenson J. Occupational injury and illness rates, 1992–96: why they fell. *Mon Labor Rev* 1998;121:36–58.
22 Blank VLG, Laflamme L, Andersson R. The impact of advances in production technology on industrial injuries: a review of the literature. *Saf Sci* 1997; 26:219–34.
23 Ussif AA. An international analysis of workplace injuries. *Mon Labor Rev* 2004;127:41–51.
24 Brooker AS, Frank JW, Tarasuk VS. Back pain claim rates and the business cycle. *Soc Sci Med* 1997;45:429–39.
25 Fabiano B, Parentini I, Ferraiolo A, *et al*. A century of accidents in the Italian industry: Relationship with the production cycle. *Saf Sci* 1995;21:65–74.
26 Robinson JC, Shor GM. Business-cycle influences on work-related disability in construction and manufacturing. *Milbank Q* 1989;67(Suppl 2):92–113.
27 Asfaw A, Pana-Cryan R, Rosa R. The business cycle and the incidence of workplace injuries: evidence from the USA. *J Safety Res* 2011;42:1–8.
28 Corvalan CF, Druiscoll TR, Harrison JE. Role of migrant factors in work-related fatalities in Australia. *Scand J Work Environ Health* 1994;20:364–70.
29 Dong X, Platner J. Occupational fatalities of Hispanic construction workers from 1992 to 2000. *Am J Ind Med* 2004;45:45–54.
30 Ahonen EQ, Benavides FG. Risk of fatal and non-fatal occupational injury in foreign workers in Spain. *J Epidemiol Community Health* 2006;60:424–6.
31 Wu TN, Liou SH, Hsu CC, *et al*. Epidemiologic study of occupational injuries among foreign and native workers in Taiwan. *Am J Ind Med* 1997;31:623–30.
32 Ministero del Lavoro e delle Politiche Sociali. *L'immigrazione per lavoro in Italia: evoluzione e prospettive*. Roma, 2011 http://www.lavoro.gov.it/NR/rdonlyres/A8D198AF-983E-459F-9CD1-A59C14C0DEA9/0/Rapporto_Immigrazione_2011.pdf
33 Ministero dell'Interno—Dipartimento per le Libertà civili e l'Immigrazione. *L'immigrazione in Italia tra identità e pluralismo culturale*. Roma, 2009 http://www.anolf.it/archivio/download/II_conferenza_immigrazione_MI_2009_2.pdf
34 Friedman Ls, Forst L. The impact of OSHA recordkeeping regulation changes on occupational injury and illness trends in the US: a time-series analysis. *Occup Environ Med* 2007;64:454–60.