SAFETY SCIENCE Monitor
Issue 2 2011
Article 5
VOL 15

YOUNG AND STRONG: WHAT INFLUENCES INJURY RATES WITHIN BUILDING AND CONSTRUCTION?

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ABSTRACT

Research has shown that young workers (<25 years old) are more exposed to injuries than older workers. However, young workers seem to be exposed to less severe injuries than older workers. The aim of this study is to explore risk factors for injuries among workers in the Norwegian construction industry, focusing especially on young workers. The study consists of a questionnaire survey (N=456) conducted in the building and construction industry in Rogaland County, Norway. Target group in the survey were workers older than 18 years within all disciplines and company sizes. The questionnaires were mainly filled out at the workers' own work site within the period Nov 2008 - Feb 2010. Logistic regression was performed on the survey data.

The results show that young workers are at a higher risk for involvement in workplace injuries compared to older workers, also when controlling for company size and type of discipline. However, when adding variables for physical and psychosocial work environment in the model, age seems to be of less importance. Physical demands (vibration and heavy lifting) and control over work pace are associated with increased risk for injuries. This may indicate that the distribution of work tasks between different age groups has an impact on injury risk. Safety climate is not associated with risk for injuries. The study indicates that the distribution of work tasks between age groups should be further explored in relation to injury risk.

INTRODUCTION

Research has shown that young workers (< 25 years) are more at risk than older workers regarding workplace injuries (Salminen, 2004; McCabe, 2008; Breslin et al., 2008). However, young workers are more exposed to non-permanent injuries (Breslin et al., 2003), while risk of fatal injuries is higher for older workers compared to younger workers (Salminen, 2004). Considering risk factors, a Canadian study found that work-related factors were predictors of work disability absence, and this study claimed that physical demands at work are risk factors for work-related absence for young workers (< 25 years), regarding both injuries and health complaints (Breslin et al., 2008).

The construction industry is shown to have a high risk for accident involvement (Kines et al., 2010). Physical demands as risk factors for both injuries and illnesses are well documented for the construction industry (Ringen et al., 1995). Furthermore, psychosocial factors have been suggested as risk factors for injuries within the same trade (Goldenhar et al., 2003; Abbe et al., 2011). Age is found as a risk factor when studying construction alone; Chau et al. (2004) stated young age (< 30 years) as one important risk factor for workplace injuries among eleven characteristics. Safety climate has been suggested as risk factor for injuries in the construction industry (Abbe et al 2011). Safety climate assessments are often used to describe employees' perceptions of how safety is dealt with at the specific workplace. These perceptions are often measured by questionnaires and provide us with a "snap shot" of the current state of safety (Mearns & Flin, 1999). Safety climate dimensions are mainly treated as leading indicators and predictors of safety performance (Mearns, 2009), and it is fairly well documented that a favorable safety climate is essential for safe operations (Mearns, Whitaker & Flin, 2003). We are not aware of any studies that have included safety climate in relation to age. Hence, there is a need for exploring safety climate in relation to age and other influencing factors.

AIM OF THE STUDY AND THE UNDERLYING MODEL

This paper explores possible explanatory factors which can contribute to our understanding of workplace injury involvement in the building and construction industry, with a focus on young workers.

The research questions are:

1. Is age an independent risk factor for injuries within the building and construction industry?
2. If there is an association between age and injuries, how is it affected by physical and psychosocial work environment and safety climate assessments?

Former research suggests age as an important factor for workplace accidents and injuries, indicating that young workers, irrespective of industry, have a higher rate of injury involvement than older workers. Therefore, our research model has age as one of the criteria variables for analyzing causes for injuries, as well as company size and type of industry/discipline, due to anticipated differences in work content and the organization of work. As earlier stated, physical and psychosocial factors at work are also shown to have an impact on accident risk, and are added to the model. An assumption is also that safety climate is of importance for injury involvement, in the sense that positive safety climate assessments are negatively related to injury involvement and vice versa. Safety climate is therefore also included in the model for this study. The model is shown in figure 1.

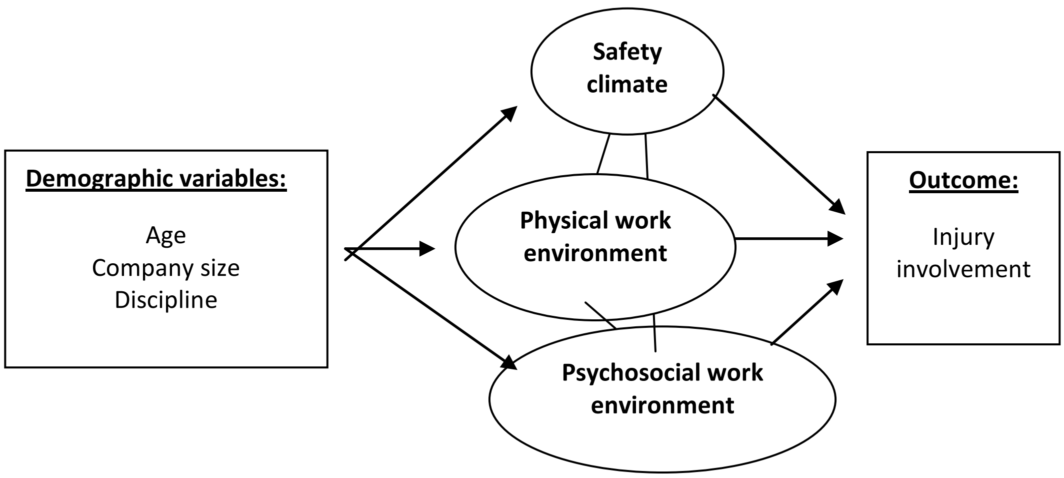

Figure 1: Anticipated dynamics between demographic variables (employee characteristics), safety climate assessments, physical and psychosocial workplace factors, and self-reported injury involvement

METHODS

Design

The study is designed as a cross-sectional questionnaire survey among building and construction workers older than 18 years.

Study population

The population includes all workers within all building and construction disciplines and company sizes. Excluded were those at age below 18 years old, not being able to read Norwegian, and workers having a solely administrative position in the organization (i.e. not at all present at the work site). Apprentices and other employees being temporarily engaged were included. Although our focus is on young workers, all age groups were included in the study, since it was of interest to explore if age constitutes an explanatory factor or not.

Data collection

The questionnaire survey was conducted in the period November 2008 – February 2010. Contact with small and large building and construction projects or companies in Rogaland County was established, asking for permission to perform a survey at the work site. After an appointment was made, the researchers visited the site during a lunch break. The questionnaires were mostly filled out during this break at the work site. Occasionally, larger groups from the same company filled out the questionnaire during a monthly assembling (e.g. HSE meeting).

Totally 474 workers answered the questionnaire. 17 questionnaires were removed from the sample, due to insufficient understanding of Norwegian. Additionally one respondent turned out to be below 18 years old. This left a total sample of 456 respondents. 445 of these respondents represent 26 pre-recruited companies, in addition to an uncertain number of subcontractors present on the days of data collection. Due to the presence of researchers at the work site the response rate on site was 98 %. In an effort for recruiting a higher number of small companies, 65 companies registered with 1-19 employees received a package of questionnaires by post. The package had a special letter for the manager of the company, signed by the regional Confederation of Norwegian Business and Industry, and each questionnaire was followed by an information letter for the worker and a post paid envelope to ensure anonymity. Only 11 of these questionnaires were completed and returned.

Background variables for the final sample are shown in table 1. Young workers (< 25 years) constitute 30.4 % of the total sample (missing N=39). 38.2 % of all respondents are unskilled or apprentices. Most respondents work within building (the raising of buildings), followed by adjacent building disciplines, labeled "building/construction techniques" (e.g. scaffolding, insulation, flooring, painting, plumbing and ventilation work), and construction (e.g. ground work and infrastructure)[1]. To counter obliquity between these groups in the analyses, carpentry is separated from the building/raising category, while electrical trades are separated from building/construction techniques because of its distinctive character. Two out of three respondents work in a ompany with more than 50 employees.

Table 1: Demographic variables

Variable	Category	%
Age	18-20 years	17,2
	21-24 years	13,2
	25-34 years	24,1
	35-44 years	20,9
	45-54 years	16
	≥ 55 years	8,6
Education	Unskilled	22,6
	Apprentice	15,6
	Skilled [a]	53,6
	University/university college	8,3

[1] These three groups are according to the classification of Norwegian vocational education

Type of discipline	Building/raising (not carpentry)	31,4
	Carpentry	21,3
	Electrical trades	13,2
	Building/construction techniques [b]	14,8
	Construction (ground work, infrastructure)	19,3
Company size	1-9 employees	5,8
	10-19 employees	10,4
	20-49 employees	16,2
	≥ 50 employees	67,6

[a] with one or more certificates of apprenticeship
[b] according to the classification of Norwegian vocational education.
Plumbing and ventilation work constitute 13,2 % of this group

Measurements

Demographics

This paper includes the following background variables: Year of birth, educational level (only used for describing the sample), company size and discipline. The categorization of disciplines was according to the NOSACQ-questionnaire (Kines et al., submitted).

Risk factors

Psychosocial work environment was assessed by single items from QPS NORDIC (Dallner, 2000). These items were related to quantitative demands, control over work pace, influence on overtime, and help and support from colleagues and superiors. Physical work demands were assessed by items from the questionnaire used by the Norwegian Petroleum Safety Authority in its frequent study Risk Level in the Norwegian Petroleum Industry (RNNP)[2]. These items were measuring vibration, physical demands related to heavy lifting, repetitive and monotonous movements, work with arms above shoulders and work with bent/twisted back or neck. All items were assessed on a five point scale from "very seldom" to "very often".

Perceptions of safety climate were assessed by the Nordic questionnaire for measuring safety climate within the building and construction industry (NOSACQ) (Kines et al., submitted). The instrument consists of seven dimensions; 1) Management safety priority, commitment and competence, 2) Management safety empowerment, 3) Management safety justice, 4) Workers' safety commitment, 5) Workers' safety priority and risk non-acceptance, 6) Safety communication, learning and trust in co-workers' safety competence, and 7) Workers' trust in the efficacy of safety systems. The 50 items which form the seven dimensions were assessed on a four point scale from "strongly disagree" to "strongly agree". Dimension structure and internal consistency (Cronbach's alpha) for the seven dimensions can be seen in table 6 in the Appendix. The Cronbach's α varies from 0.681 to 0.848, indicating good internal consistency within the dimensions[3].

Outcome variable

For this study the outcome variable is injury involvement. In the questionnaire, the respondents were asked if and how many times the last six months they had been hurt in a specific accident where they had to stop working for one hour or more. Each of the alternatives were formed as an individual question, with categories "yes" and "no" (pinch, hit, collision, electrical shock, fall on same level, fall from height, object in the eye, cut or scratch, violent threat, overstrain, being buried). A sum score was made and the respondents were classified as "injured" and "not injured", irrespective of one or several injures.

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[2] www.ptil.no/rnnp, see for instance:.Norwegian Petroleum Safety Authority (2010). Trends in risk level in the petroleum activity. Summary report 2009 – Norwegian continental shelf

[3] The safety climate dimensions have also been tested through exploratory and confirmatory factor analysis on our specific sample. Based on the results of these analyses it was decided to go further with the seven validated dimensions.

Analyses

A descriptive analysis was performed for risk factors and outcome; for each item describing physical and psychosocial work environment and for each of the safety climate dimensions. Mean and SD were calculated, and t-tests were used to find significant differences in risk factors according to age and injury involvement. Correlations between measurements were analyzed by Spearman's r, due to lack of normal distribution (see table 2 for mean and SD).

Finally, a stepwise logistic regression was performed, using injury involvement (injured/not injured) as outcome variable. The analysis had age as the independent variable in step 1, company size in step 2, discipline in step 3, workplace factors in step 4-6 and safety climate dimensions in step 7. For every variable or dimension used in the regression analysis, a t-test had been performed to determine which group was least involved in injuries. The group least involved was consequently set as reference category. Variables based on response scales were split in two (values below and above mean), yielding workplace factors and safety climate dimensions (see table 2). Based on the number of missing in each of the variables/dimensions used in the analysis, the stepwise logistic regression contains 380 questionnaire answers.

Values for Cox & Snell R^2 and Nagelkerke R^2 were calculated for every step in the logistic regression analysis.

The statistical analysis was performed in SPSS 18.0.

RESULTS

Injury involvement

In the total sample, 36 % (valid percent) report that they during the last six months have been injured at work and had to stop working for at least one hour. The distributions of accidents and workers within each age group are shown in Figure 2. Young workers below 25 year of age seem to be overrepresented with self-reported workplace injuries. Workers between 25 and 35 have a similar, but less clear tendency, while workers 35 years and older seem to be less involved in injuries than their sample presence should indicate. Considering type of injuries, cuts/scratches are the most frequent injuries for all ages and for young workers in particular. 34.2% of workers 18-20 years have experienced this during last six months. However, young workers are also more involved in injuries related to objects in the eyes, lifting/overstrains, and fall at the same level. Older workers (≥ 55 years) are more involved accidents like collisions (10.8 % last six months) or falls on the same level (13.5 % last six months), and this group also has a considerable share of scratches/cuts and collisions compared to other groups over 25 years.

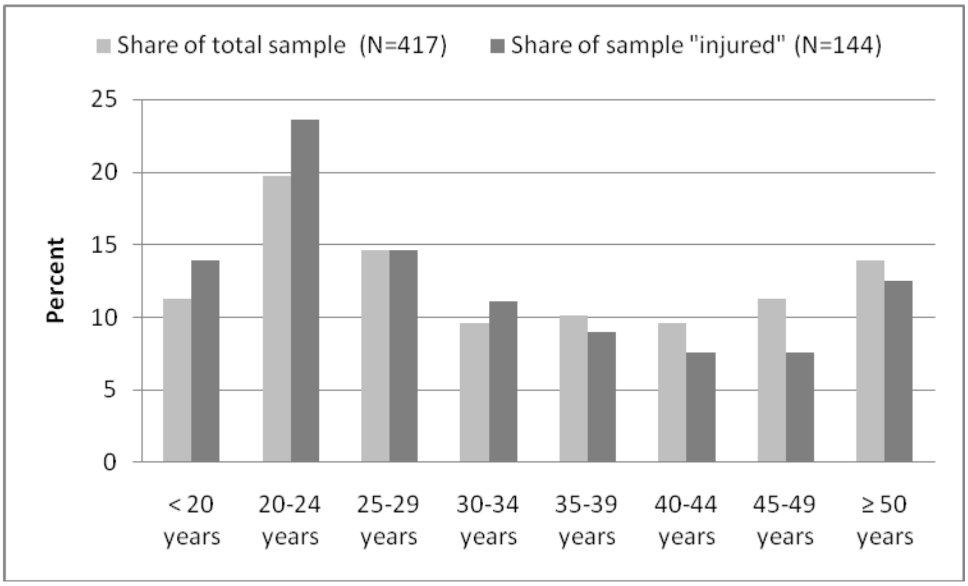

Figure 2: Age and contribution in total sample and total injury sample

Means

Estimated means for all workplace factors and safety climate dimensions used in the analyses are shown in table 2.

Physical and psychosocial factors

T-tests show that respondents who report an injury during the last six months report a significantly higher degree of *vibrations*, *heavy lifting*, *repetitive movements*, *arms above shoulders and bent/twisted back or neck* in their work than respondents not reporting an injury (all: p=0.000). Those who are classified as injured also report less ability to decide their own work pace (p=0.028) and amount of overtime (p=0.039).

When it comes to age (results not shown), young workers (< 25 years) report significantly more physical work demands than older workers; namely *vibrations* (p=0.023), *heavy lifting* (p=0.000), *repetitive movements* (p=0.005), and working with *arms above shoulders* (p=0.001). At the same time, the young workers also report more support from their colleagues (p=0.001) and support from their superior (p=0.039).

Table 2: Means and standard deviation for items/dimensions used

Concept	Variable/dimension	Scale	Mean	SD	Mean (not injured)	Mean (injured)
Work demands	Are you exposed to vibrations in hands/arms from machinery or equipment?	A	2,89	1,17	2,68	3,27***
	Do you perform heavy lifting?	A	3,30	1,07	3,05	3,74***
	Do you perform repetitive and monotonous movements?	A	3,25	1,04	3,11	3,49***
	Do you work with your arms above your shoulders?	A	3,28	1,15	3,07	3,65***
	Do you work with bent/twisted back or neck?	A	3,19	1,10	3,00	3,53***
	Is it necessary to work in a high pace?	A	3,43	0,92	3,39	3,49
Control	Can you decide your own work pace?	A	3,58	0,93	3,66	3,44*
	Can you decide how much overtime you have to work?	A	3,44	1,31	3,54	3,26*
Support	If you need it, do you get support and help from your colleagues?	A	4,10	0,80	4,13	4,05
	If you need it, do you get support and help from your superior?	A	3,83	0,97	3,89	3,72
Safety climate	(1) Management safety priority, commitment and competence	B	3,06	0,45	3,09	3,00*
	(2) Management safety empowerment	B	2,93	0,41	2,97	2,86*
	(3) Management safety justice	B	3,04	0,42	3,09	2,96**
	(4) Workers' safety commitment	B	3,11	0,40	3,15	3,06*
	(5) Workers' safety priority and risk non-acceptance	B	2,89	0,49	2,94	2,80**
	(6) Safety communication, learning and trust in co-workers' safety competence	B	3,06	0,40	3,10	3,01*
	(7) Workers' trust in the efficacy of safety systems	B	3,15	0,43	3,18	3,12

A: 1=very seldom, 5=very often
B: 1=strongly agree, 4=strongly disagree (in positive formulated statements)
p≤0,001=***, p≤0,01=**, p≤0,05=*

Safety climate dimensions

T-tests show that respondents classified as "not injured" have significantly more positive safety climate assessments on six out of seven dimensions ($p \leq 0.044$). The two dimensions with strongest relation with injuries are *Management safety justice* ($p=0.003$), which contains items which address how the management treats employees involved in accidents, and *Workers' safety priority and risk non-acceptance* ($p=0.003$), which address the risk perception and safety behaviour among the colleagues. See table 6 in the Appendix for details on included items and table 2 for means.

Considering age and safety climate assessments, there were no differences on dimension level (results not shown). However, an analysis of single items shows that young workers significantly differ from older workers in assessing risk taking in the work environment (young workers more agree) ($p=0.005$) and in perceiving management to place safety before production (young workers more agree) ($p=0.032$). Older workers on the other hand, have significantly less confidence in the management's ability and willingness to take safety problems seriously ($p=0.015$), as well as less faith in early safety planning (0.048).

Correlations

Correlations between age and risk factors (physical and psychosocial work environment, and safety climate dimensions) are shown in table 3. Work demand variables correlate strongest with each other, which is also the case for the safety climate dimensions. *Age* is significantly correlated with *vibrations* ($p=0.041$), *influence on overtime* ($p=0.006$), *support from colleagues* ($p=0.002$) and *support from superior* ($p=0.024$), but these correlations are weak. *Vibrations* and *heavy lifting* is significantly correlated with the first six safety climate dimensions ($p \leq 0.005$), and *bent/twisted back or neck* is significantly correlated to four of the safety climate dimensions. Neither of these correlations are strong ($r<0.3$).

Table 3: Correlations between age, workplace factors and safety climate dimensions (strongest correlations in grayscale, r<0.3)

	Variable/dimension	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Age	1,000	-.099 *	-.086	-.054	-.080	-.068	-.019	-.095	-.133 **	.153 **	.110 *	-.083	.040	.068	-.073	.094	.008	.051
2	Vibrations		1.000	.219 ***	.122 *	.224 ***	.214 ***	.116 *	.102 *	.053	.073	.097 *	-.157 ***	-.176 ***	-.135 **	-.144 **	-.177 ***	-.202 ***	-.155 **
3	Heavy lifting			1.000	.401 ***	.370 ***	.431 ***	.221 ***	.109 *	.031	.082	.069	-.153 ***	-.164 ***	-.181 ***	-.152 ***	-.235 ***	-.173 ***	-.096 *
4	Repetitive movements				1.000	.340 ***	.348 ***	.277 ***	.129 **	.069	.071	.100*	-.079	-.120 *	-.088	-.092	-.159 ***	-.085	-.037
5	Arms above shoulders					1.000	.520 ***	.088	.088	.110 *	.015	.090	-.074	-.149 **	-.056	-.025	-.122 *	-.073	-.018
6	Bent/twisted back or neck						1.000	.232 ***	.170 ***	.072	.076	.086	-.150 **	-.187 ***	-.102 *	-.155 ***	-.170 ***	-.110 *	-.115 *
7	Working in high pace							1.000	.217 ***	-.060	.090	.099 *	-.086	-.119 *	-.136 **	-.064	-.149 **	-.096 *	-.072
8	Control over work pace								1.000	.243 ***	.170 ***	.211 ***	-.140 **	-.131 **	-.157 ***	-.096 *	-.156 ***	-.086	-.089
9	Influence on overtime									1.000	.114 *	.125 **	-.086	-.065	-.058	-.084	-.148 **	-.079	-.074
10	Support from colleagues										1.000	.356 ***	-.275 ***	-.196 ***	-.280 ***	-.245 ***	-.169 ***	-.267 ***	-.261 ***
11	Support from superior											1.000	-.281 ***	-.229 ***	-.221 ***	-.190 ***	-.182 ***	-.215 ***	-.169 ***
12	Safety climate (1)												1.000	.471 ***	.454 ***	.524 ***	.404 ***	.468 ***	.502 ***
13	Safety climate (2)													1.000	.308 ***	.348 ***	.338 ***	.333 ***	.295 ***
14	Safety climate (3)														1.000	.412 ***	.305 ***	.468 ***	.433 ***
15	Safety climate (4)															1.000	.378 ***	.583 ***	.471 ***
16	Safety climate (5)																1.000	.365 ***	.397 ***
17	Safety climate (6)																	1.000	.588 ***
18	Safety climate (7)																		1.000

p≤0,001=***, p≤0,01=**, p≤0,05=*

Logistic regression

The results from the stepwise logistic regression are shown in table 4, and the strongest relations (regarding both p-value and confidence interval) are marked dark grey. Light grey indicates significant results with $p \leq 0.05$.

Low age is a significant explanatory factor for injury involvement, also when controlling for company size (step 2) and discipline (step 3). However, disciplines is an independent significant factor, where being employed within building/raising, carpentry and building/construction techniques is associated with increased injury risk. When work demands are added to the model (step 4), age is ruled out as an explanatory factor for injuries. In this step, *vibrations* and *heavy lifting* show significant associations with risk of injuries. At the same time, the category *building/construction techniques* looses its significance, while *electrical trades* becomes significant. Items for control (step 5) does not change the status for work demand variables, but *control over work pace* shows a significant relation with injuries. It also strengthens the relation between carpentry and injuries. Adding the seven dimensions for safety climate (step 7) does not further contribute to explaining injury involvement[4], but, the two disciplines *building/raising* and *electrical trades* are not longer significant is step 7. A t the end, the stepwise logistic regression analysis indicates *carpentry*, *vibrations*, *heavy lifting* and *control over work pace* as significant explaining factors for injuries. The strongest independent variable is carpentry.

[4] The regression analysis has also been performed using safety climate dimensions in step 4, pushing variables for work demands, control and support to steps 5-7. This switch made no considerable difference in the relation between age, type of industry and risk for injuries.

Table 4: Stepwise logistic regression

		Step 1[a]		Step 2[a]		Step 3[a]		Step 4[a]		Step 5[a]		Step 6[a]		Step 7[a]	
Variable	**Category**	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95%CI	OR	95%CI	OR	95%CI
Age [b]	< 25 years	1,62*	(1,03-2,55)	1,68*	(1,06-2,66)	1,69*	(1,03-2,79)	1,40	(0,83-2,36)	1,39	(0,82-2,37)	1,41	(0,82-2,42)	1,41	(0,81-2,47)
Company size [c]	1-9 employees			1,58	(0,67-3,73)	1,39	(0,57-4,00)	1,23	(0,47-3,23)	1,34	(0,51-3,56)	1,27	(0,47-3,40)	1,15	(0,42-3,12)
	10-19 employees			1,09	(0,54-2,23)	0,88	(0,41-1,86)	0,92	(0,42-2,02)	0,90	(0,41-1,98)	0,91	(0,41-2,00)	0,97	(0,43-2,22)
	20-49 employees			1,39	(0,78-2,49)	0,92	(0,48-1,74)	0,84	(0,43-1,66)	0,88	(0,44-1,76)	0,86	(0,43-1,74)	0,80	(0,38-1,66)
Discipline [d]	Building/raising (not carpentry)					2,40*	(1,19-4,85)	2,15*	(1,01-4,57)	2,21*	(1,03-4,74)	2,26*	(1,05-4,86)	2,07	(0,94-4,56)
	Carpentry					4,53*	(2,09-9,82)	3,88**	(1,67-9,03)	4,29***	(1,82-10,11)	4,34***	(1,83-10,27)	4,12**	(1,70-10,01)
	Electrical trades					2,23	(0,95-5,26)	2,61*	(1,00-6,83)	2,79*	(1,06-7,34)	2,76*	(1,05-7,27)	2,52	(0,93-6,85)
	Building/Construction techniques (not electrical trades)					2,44*	(1,03-5,75)	2,07	(0,83-5,22)	2,06	(0,81-5,27)	2,04	0,79-5,25	2,02	(0,77-5,32)
Work demands [e]	Vibrations							1,94*	(1,12-3,35)	1,85*	(1,07-3,20)	1,86*	(1,07-3,23)	1,95*	(1,11-3,43)
	Heavy lifting							2,03*	(1,17-3,52)	2,01*	(1,15-3,50)	2,01*	(1.15-3,51)	1,89*	(1,06-3,35)
	Repetitive movements							1,55	(0,90-2,66)	1,55	(0,89-2,68)	1,56	(0,90-2,72)	1,55	(0,89-2,72)
	Arms above shoulders							0,72	(0,39-1,31)	0,71	(0,39-1,30)	0,70	(0,38-1,29)	0,75	(0,40-1,39)
	Bent/twisted back or neck							1,73	(0,95-3,15)	0,68	(0,92-3,09)	1,69	(0,92-3,09)	1,69	(0,91-3,15)
	Working in high pace							0,76	(0,46-1,26)	0,68	(0,40-1,14)	0,67	(0,40-1,13)	0,67	(0,39-1,14)
Control [e]	Control over work pace									1,77*	(1,08-2,92)	1,74*	(1,05-2,90)	1,67*	(1,01-2,85)
	Influence on overtime									0,90	(0,55-1,47)	0,90	(0,54-1,47)	0,88	(0,53-1,47)
Support [e]	Support from colleagues											0,78	(0,45-1,35)	0,75	(0,42-1.34)
	Support from superior											1,36	(0,79-2,36)	1,41	(0,80-2,46)
Safety climate [e]	(1) Management safety priority, commitment and competence													0,66	(0,34-1,28)
	(2) Management safety empowerment													1,12	(0,64-1,97)
	(3) Management safety justice													1,61	(0,85-3,09)
	(4) Workers' safety commitment													1,61	(0,84-3,20)
	(5) Workers' safety priority and risk non-acceptance													0,98	(0,57-1,76)
	(6) Safety communication, learning and trust in co-workers' safety competence													0,91	(0,45-1,83)
	(7) Workers' trust in the efficacy of safety systems													0,57	(0,29-1,13)

[a] p≤0,001=***; p≤0,01=**; p≤0,05=*; OR= odds ratio (Exp(B)); CI=confidence interval; significant associations marked grey (strongest associations in dark grey)

[b] Reference category : ≥ 25 years

[c] Reference category: ≥ 50 employees

[d] Reference category: construction (e.g. ground work, infrastructure)

[e] Reference category: the least injured group, when split in two around mean

Values for Cox and Snell R^2 and Nagelkerke R^2 are shown in table 5. The values support the indications of company size having little or no relations with injury involvement (step 1-2). The increase between step 2 and 3 gives strength to the results on discipline importance, while the largest increase is between step 3 and 4, where the physical work demands are added to the analysis. All in all, physical and psychosocial factors give the largest contribution to the explained variance in this analysis.

Table 5: Measures to indicate explained variance in the stepwise logistic regression

Steps	Cox & Snell R^2	Nagelkerke R^2
Step 1	0,011	0,016
Step 2	0,017	0,023
Step 3	0,057	0,079
Step 4	0,137	0,189
Step 5	0,148	0,204
Step 6	0,152	0,209
Step 7	0,167	0,231

DISCUSSION

The two main findings of this study are; 1) that young workers have an increased risk for injury involvement, as well as a somewhat different picture of injury types compared to older workers, and 2) that physical and psychosocial factors moderate the association between age and injuries, especially physical work demands (vibration and heavy lifting) and control over work pace. Safety climate did not alter the effect of age, neither did the background variables (company size and discipline).

Discipline showed an independent association with injuries, with carpentry having the strongest association. Safety climate changed the importance of discipline, were only carpentry showed a s ignificant increased risk for injury involvement in the full model (all 7 steps).

The results show young age as an important factor for workplace injury involvement. This is in correspondence with other research findings (Salminen, 2004; McCabe, 2008; Breslin et al., 2008). Earlier results saying that young workers have less severe injuries (Breslin et al., 2003) are partially confirmed, taking into consideration that our sample represents a low number of injuries, and that no deaths are included in the material. According to the self-reported injuries presented in this study, it seems that injury rates are declining at the age of 25. This is in line with other studies. Libscomb et al. (2003) showed that carpentry apprentices had three times the risk for injuries using nail-guns compared to skilled workers, but that the injury rate decreased during the period of apprenticeship.

The regression analysis showed that both physical and psychosocial work factors were associated with injury involvement. Physical demands are known as risk factors for injuries in the construction industry (Ringen et al, 1995). The findings in this study are therefore not surprising. Work demands did however reduce the association between young age and injury involvement. The t-tests did showed a higher exposure to physical work demands among young workers; namely vibrations, heavy lifting, repetitive movements and working with arms above shoulders, where vibration and heavy lifting turned out to be significant also in the regression analysis. This is in accordance with the research findings in Breslin et al. (2007), showing that physical demands were a risk factor for young workers, and stating that this could be related to the distribution of work tasks between age groups. This result may reflect the distribution of work tasks between age groups also in our study. Unpublished interview data within the same industry indicate that during the distribution of work tasks, young workers are allocated to the physical work tasks. This indicates that young workers also become more exposed to hazards and work tasks which may increase the accident risk.

Another factor shown to affect injury involvement is control over work pace, where high control gave reduced risk of workplace injury. Job control has been found to associate with injuries in other studies (Abbe et al., 2011). The feeling of control increases the ability of handling high work demands (Karasek & Theorell, 1980). Those reporting a high degree of control over work pace may have a higher opportunity to prioritize safety in their work, which in the end can reduce risk for injuries. The perceived control may also be related to experience and responsibility (i.e. age). More experience can give a better overview over the performance, as well as better skills and abilities to perform work tasks faster.

Safety climate did not show any association with injury risk in the regression analysis, nor did it alter the association between age and injury risk. No age differences were found on dimension level, which can explain why safety climate assessments did not alter the association between age and injuries. However, some differences were found between age groups on single item level in the t-tests. It may also be of relevance that the split in age groups in the regression analysis was at age 25. As most Norwegian apprentices enter work life at the age of 17 or 18, they are considered experienced workers at age 25. They are beyond their period of early career, where their perceptions of attitudes towards safety are shaped.

The analysis of single items showed that young workers assess a higher level of risk-acceptance at work, which can be an expression for their own high safety attitudes and critical opinion on colleagues' work practice, or their lack of experience and hence higher risk perception. After some years of work, this critical perception may decline, as they become more integrated in the joint culture and ways of working. This assumption can explain why older workers are more critical towards early safety planning and the management's handling of safety problems, as they emphasize their experience of the company's actual safety handling more than the apprehension on how it ideally should be. The decreased critical assessments of risk acceptance associated with higher age may on the other hand (or at the same time) also indicate that more experience reduces their risk perception related to their workplace.

There are some limitations in this study. Recruiting small and medium-sized companies turned out to be a considerable challenge. This may have affected the results of this study. It can be anticipated that the non-findings on safety climate dimensions and injury involvement are caused by most respondents belonging to companies with more than 50 employees. We assume large companies to have more systematic efforts considering occupational health and safety compared to smaller companies. A company's effort may have impact on the workers' perceptions of safety management, and we assume our material to reflect assessments made by respondents mainly employed in companies with more "visible" efforts. Few respondents from small companies therefore give less variation in the material.

The regression analysis contains 18 independent variables. The sum of missing cases constitutes a challenge, which could have been of less importance if the sample was larger.

When it comes to the reporting of injuries, it may be differences between age groups in the severity of reported injuries. It may be anticipated that older workers tend to report less of the small injuries (cuts/scratches) compared to younger workers, simply because the injuries are considered frequent and part of the work. Additionally, it can be assumed less recall bias associated with a six months report period for young workers than for experienced workers, which may affect the amount of reported injuries in the different age groups. This may further affect the results and lead to an overestimation of age as a risk factor for workplace injuries.

During the project period a financial crisis evolved around the world, affecting the national economies and labor markets to different extents. This financial crisis did also reach Norway, but to a lesser degree than for most countries, mainly caused by oil prices as a strong contributor to the Norwegian economy. Moreover, the project is carried out in the region which is mostly influenced by international oil trade cycles, and the financial crisis' expected negative effect on labor and activity within building and construction has therefore been small or nearly absent. This situation separates Norway from other Nordic countries in the study period.

ACKNOWLEDGEMENTS

This work was supported by a grant given by the Foundation for regional safety delegates in the Norwegian construction industry. The project has been performed in collaboration with representatives from the building and construction industry in Rogaland County, Norway. We appreciate their help regarding access to companies within their disciplines. We will also give our thanks to researcher Kjersti Lunde Ellingsen at IRIS for her efforts during data collection and in the preliminary analyses.

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APPENDIX

Table 6: Dimension structure and internal consistency (Cronbach's alpha)

DIMENSIONS AND ITEMS	α
1 Management safety priority, commitment & competence	0,848
Management encourages employees here to work in accordance with safety rules - even when the work schedule is tight	
Management ensures that everyone receives the necessary information on safety	
Management looks the other way when someone is careless with safety	
Management places safety before production	
Management accepts employees here taking risks when the work schedule is tight	
We who work here have confidence in the management's ability to handle safety	
Management ensures that safety problems discovered during safety rounds/evaluations are corrected immediately	
When a risk is detected, management ignores it without action	
Management lacks the ability to handle safety properly	
2 Management safety empowerment	0,716
Management strives to design safety routines that are meaningful and actually work	
Management makes sure that each and everyone can influence safety in their work	
Management encourages employees here to participate in decisions which affect their safety	
Management never considers employees' suggestions regarding safety	
Management strives for everybody at the worksite to have high competence concerning safety and risks	
Management never asks employees for their opinions before making decisions regarding safety	
Management involves employees in decisions regarding safety	
3 Management safety justice	0,684
Management collects accurate information in accident investigations	
Fear of sanctions (negative consequences) from management discourages employees here from reporting near-miss accidents	
Management listens carefully to all who have been involved in an accident event	
Management looks for causes, not guilty persons, when an accident occurs	
Management always blames employees for accidents	
Management treats employees involved in an accident fairly	
4 Workers' safety commitment	0,681
We who work here try hard together to achieve a high level of safety	
We who work here take joint responsibility to ensure that the workplace is always kept tidy	
We who work here do not care about each others' safety	
We who work here avoid tackling risks that are discovered	
We who work here help each other to work safely	
We who work here take no responsibility for each others' safety	
5 Workers' safety priority & risk non-acceptance	0,755
We who work here regard risks as unavoidable	
We who work here consider minor accidents as a normal part of our daily work	
We who work here accept dangerous behavior as long as there are no accidents	
We who work here break safety rules in order to complete work on time	
We who work here never accept risk-taking even if the work schedule is tight	
We who work here consider that our work is unsuitable for cowards	
We who work here accept risk taking at work	
6 Safety communication, learning & trust in co-workers' safety competence	0,842
We who work here try to find a solution if someone points out a safety problem	
We who work here feel safe when working together	
We who work here have great trust in each others' ability to ensure safety	
We who work here learn from our experiences to prevent accidents	

We who work here take each others' opinions and suggestions concerning safety seriously	
We who work here seldom talk about safety	
We who work here always discuss safety issues when such issues come up	
We who work here can talk freely and openly about safety	
7 Workers' trust in the efficacy of safety systems	0,805
We who work here consider that a good safety representative plays an important role in preventing accidents	
We who work here consider that safety rounds/evaluations have no effect on safety	
We who work here consider that safety training is good for preventing accidents	
We who work here consider early planning for safety as meaningless	
We who work here consider that safety rounds/evaluations help find serious hazards	
We who work here consider that safety training is meaningless	
We who work here consider that it is important that there are clear-cut goals for safety	