Incidence[Q1] of Work Injuries Amongst Danish Adolescents and Their Association With Work Environment Factors

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Background *The objective was to examine the incidence of work accidents that required medical attention among Danish adolescents and to identify possible work environment factors associated with such accidents.*

Methods *We collected information in two questionnaire rounds (2004 and 2007) from a birth cohort comprising all adolescents born in 1989 (n = 3,687) living in Ringkjøbing County, Denmark. The questionnaire contained items on self-reported number of accidents and number of working hours in both rounds and on work environment factors in the second round.*

Results *Approximately 5% of the adolescents who held a job, experienced a work injury at the age of 17. This equals an incidence of 65 accidents per million working hours. Most adolescents had decent working conditions, although nearly half reported that their work was heavy, monotonous or psychologically demanding. Heavy work, high psychological demands and low social support increased the risk of experiencing work injuries after adjustment for a number of factors.*

Conclusions *The incidence of work injuries among adolescents appears to be higher than the incidence among their older colleagues. Lack of social support from management significantly raised adolescents' risk of experiencing a work injury. This suggests that more direct supervision may be a good way of preventing accidents in this age group.* Am. J. Ind. Med. 00:1–9, 2010. © 2010 Wiley-Liss, Inc.

KEY WORDS: Denmark; adolescents; work accidents; injuries; work environment; lifestyle

INTRODUCTION

In Denmark, the incidence of work accidents among employees aged 18–24 years is higher than that of the rest of the work force and it has risen by 20% over the past 6 years (2003–2008) [The Danish Work Environment Authority,

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2009]. It is assumed that the national notification system does not give reliable figures for those under 18 years of age because of underreporting related to the specific type of labor market participation of young employees (part time jobs, frequent job changes, etc.). Data from emergency departments, which provide more reliable figures, show approximately 23 incidents demanding hospital treatment per 1,000 persons in the 15 to 19-year age group and approximately 14 for those aged 45–64 years, that is, a more than 50% risk level difference [National Institute of Public Health, 2009]. Unadjusted for working hours, these figures do not take into account the fact that adolescents are generally employed in part-time jobs in their spare time and therefore work fewer hours than the 45–64-year-old employees, who mostly work full time. Thus, taking into account the actual working hours

of adolescents might substantially increase the relative risk of work injuries for this age group compared to other age groups. The Danish national rates of reported injuries show a 20% higher occurrence of injuries among those aged 18–24 years—even though the rate of underreporting is estimated to be approx. 70% [The Danish Working Environment Authority, 2008]. Underreporting is rooted partly in the reporting procedure, which stipulates that the employer must report accidents to the Danish Working Environment Authority if the employee becomes unfit for work for 1 day or more after the day of the accident. However, as many adolescents work only part-time and are not necessarily at work every day, they may not be absent from work even if they suffered an accident that would have been notified if they had been adults, simply because they were not scheduled to be at work. This causes systematic underreporting of accidents among adolescents and other part-time employees. We thus lack precise estimates of the real incidence of work-related accidents among adolescents. This is essentially no different than in the rest of the world. Moreover, the lack of a common definition of work accidents makes it even more difficult to obtain precise, comparable estimates of the prevalence of this problem in general, and among adolescents in particular [Runyan and Zakocs, 2000].

The body of literature on adolescent work injuries is substantial. The studies fall into three broad categories: studies based on emergency department data, studies based on worker compensation registers, and finally, self-report surveys. While the first two types of studies are often representative, they rarely contain information about those work-related factors that might cause accidents. Studies using self-reported data are often based on small, non-representative samples, which makes the question of generalization problematic. Overall, most of these studies have been descriptive analyses of, for example, injury occurrence by type of injury, occupational branch, gender, education and training, etc. [for a review of the American literature, see Runyan and Zakocs, 2000]. Only a few of these studies have had an analytic approach, aiming, for instance, to find predictors of work injuries among adolescents, and even fewer have examined this question using a multivariate approach. The primary risk factors for work accidents among adolescents identified in existing studies include physical hazards, excessive workloads, perceived work-pace pressure, personality factors, poor physical health, and substance use [Stueland et al., 1996; Frone, 1998; Evensen et al., 2000; Shipp et al., 2005]. Rather than using a multivariate approach, most of these studies have examined the association between a few of these factors and work accidents. The only exception is Frone [1998] who found that job tenure, exposure to physical hazards, excessive workload and job boredom all contributed to a higher risk of suffering work accidents, even when adjusting the results for the other work characteristics as well as gender, personality factors,

health, and substance use. However, their sample was non-representative and we therefore do not know whether this result can be generalized to adolescents elsewhere.

The majority of the previously conducted studies were localized to an American or Canadian setting. While general predictors of work accidents among adolescents will likely not vary substantially between countries, there will be differences in the prevalence of the factors producing work accidents for this age group as adolescent job types vary between countries. Evidence on work accidents among adolescents from a non-North American context are also interesting because it provides insight into potential differences in the nature and incidence of work accidents rooted in legislative differences and in the nature and kinds of jobs that this group may hold.

The aims of this paper are (1) to estimate the incidence of work accidents among Danish adolescents, and (2) to establish which work environment factors are most closely associated with work accidents that demand medical attention among adolescents. We used multivariate statistics including a broad variety of both work environment as well as lifestyle factors. This study allows us to better understand the relative contribution of each of these factors to the risk of experiencing a work accident.

MATERIALS AND METHODS

Data

The data were taken from the first and second round of VestLiv—the West Jutland Cohort Study, a static birth cohort study of all individuals born in 1989 living in the county of Ringkjøbing, Denmark in early April 2004. The questionnaires were for the most part (65%) handed out to the participants while they were attending school in May 2004. Questionnaires were mailed to those who were not present (or who were attending schools that declined the invitation to participate). A second round was conducted in the autumn of 2007 and data were collected using a combination of internet and postal questionnaires. All participants were asked to give informed consent before answering the questionnaire.

The cohort comprised 3,687 individuals of whom 3,057 answered the first-round questionnaire (response rate 83%). Everyone who had not opted out of the study (n = 3,293) was sent the second-round questionnaire of whom 2,328 answered (response rate 71%); 2,181 individuals participated in both rounds (59% of the original cohort).

Using information from the Central Office of Civil Registration (CPR) in which the respondents are linked to their legal parents or guardians via a personal identification number given to everyone in Denmark at birth (or upon entry for immigrants), the questionnaire data were linked to information from official registers held at Statistics Denmark. Using register-based information, an analysis of the

non-responders showed that on average they had poorer and less educated parents and that they were more often foreigners. The study as well as the linking of information using CPR was approved by the Danish Data Protection Agency (Study No. 2009-41-3761).

Outcome

Two questions were used as the outcome measures. First, respondents were asked how many accidents they had experienced during the past 12 months that had required medical attendance. The response categories included: "none," "one," "two," "more than two." Second, those reporting a minimum of one accident were asked to specify in which category the most serious of these accidents fell. The response categories were: "traffic accident," "sports accident," "work accident," "accident at educational institution," "accident at home," and "other." Both questions were asked in round 1 as well as in round 2. For use in this paper, we created two dichotomous variables to establish whether the respondent had reported a work accident as the most serious of the accidents he/she had experienced in either round.

Independent Variables

Working hours

We estimated the incidence of work accidents per million working hours by extracting information from the questionnaire on the number of self-reported working hours for the participants in round 1 as well as in round 2. All subsequent analyses were adjusted for the number of working hours to reflect the actual time each participant spent at risk of experiencing a work accident. Participants who did not hold a job were excluded from the multivariate analyses (n = 518).

Work environment

Physical work environment: monotonous repetitive work and heavy lifting was measured using two single items from the Dutch Musculoskeletal Questionnaire (DMQ) [Hildebrandt et al., 2001]. The nine questions measuring different aspects of the participant's psychosocial work environment have all been used in other Danish studies [Andersen et al., 2007]. Appendix 1 shows the full wording and response categories of these variables.

Lifestyle factors

Lifestyle was measured using three questions: one indicating whether the participant smoked daily, one measuring overall alcohol consumption over the past 30 days, and one

indicating whether the participant had consumed a minimum of five units of alcohol in a row over the past 30 days. The full wording is shown in appendix 1.

Statistical analysis

Multiple logistic regression models were used to study the association between work accidents and work environment. Three models were tested: we calculated the association between each of the independent variables and work accidents adjusted for number of working hours only (Model 1). After this procedure, several independent variables were removed because they were not significantly associated with the outcome ($P > 0.20$). The following variables were removed: binge drinking, monotonous work tasks, and working climate. We then applied a new model in which all the remaining variables were mutually adjusted for each other and for number of working hours (Model 2). Finally, we used a model in which stepwise backwards selection was used to reduce the number of independent variables (Model 3). The aim of this approach was to obtain an appropriate number of independent variables per outcome. The final model contains six independent variables, which are within the bounds of the 5–10 cases with events per independent variable often stated as the ideal in the literature [Bagley et al., 2001]. The Hosmer–Lemeshow Goodness-of-fit was used to evaluate the quality of the models [Hosmer et al., 1997]. The inclusion of working hours reduced the fit of the model. However, removing working hours from the analyses produced significant differences in some of the estimates, for example, job type, and it was therefore decided to keep working hours in the model. We tested for interaction effects between all independent variables selected for the final model (i.e., 20 interaction effects). Among the interaction terms between the final six independent variables, one came out as statistically significant (psychological demands × social support from management), but inclusion of the interaction term into the model yielded an inferior Goodness-of-fit and the result of the interaction term was non-interpretable. We interpret the significant interaction term as a consequence of random type 1 error. All regression models were conducted using only respondents with no missing data. All in all, the sample used for the multivariate analyses consisted of 1,610 respondents; participants with missing data on any of the variables were excluded (n = 211). The analyses were performed using STATA 11.

RESULTS

Table I shows the result for the study sample obtained in round 2. Most adolescents (60%) worked in their spare time only, but a large proportion of apprentices and a minority (6%) had ordinary jobs as their main activity. More than 85% of the working adolescents were satisfied with their work,

TABLE I. Description of Study Population in Round 2

	N	%
Job type[a]		
No job	520/1,821	22.1
Spare time jobs (held while studying/having an apprenticeship)	1,388/941	59.6
Working as an apprentice	420/1,980	17.5
In ordinary jobs (as opposed to studying/having an apprenticeship)	134/2,187	5.8
Gender		
Girls	1,265/2,328	54.3
Lifestyle		
Consumed alcohol > 10 days during the past month (alcohol consumption)	208/2,120	8.9
Intoxicated once or more during the past month (binge drinking)	945/1,369	40.8
Smokes daily	355/1,973	15.2
Work environment (% of those in job n = 1,823)[b]		
Heavy lifting	703/987	41.6
Monotonous work tasks	813/871	48.2
High psychological demands	819/866	48.6
No social support from colleagues	133/1,547	7.9
No social support from management	250/1,430	14.9
Bad working climate	73/1,600	4.4
Low degree of influence on work tasks	557/1,137	32.9
Bullied at least once during past year	144/1,535	8.6
Time pressure	132/1,553	7.8
Dissatisfied with work	270/1,426	15.9

Proportion of participants with different work environment factors and lifestyle factors (N = 2,328).
[a]The job types do not sum to 100% because it was possible for the adolescents to indicate that they held a spare time job besides having an apprenticeship.
[b]N for each variable differs between the individual variables due to missing data.

even if a large proportion (>40%) reported heavy lifting, monotonous work tasks, or psychologically demanding work tasks. The psychosocial work environment was reported by most to be partly healthy: <5% reported a poor working climate and 9% reported having been "bullied in an unpleasant way" at least once during the past year. However, a small group (15%) indicated that they received insufficient social support from their management when they were experiencing work-related problems. In addition, 8% did not receive sufficient social support from their colleagues.

Table II contains an estimate of the incidence of work accidents based on the number of weekly hours worked as reported by the participants. The proportion of working adolescents rose from 66% at the age of 14–78% at the age of 17. The number of working hours per week more than doubled from 7.5 at the age of 14–16 hr per week at the age of 17. This entailed an increase in the proportion of working adolescents having experienced a work accident during the past 12 months from 2.8% to 4.7% from the age of 14 to the age of 17 years. However, taking into account the increase in average working hours, the incidence of work accidents decreased from 89 per million working hours at the age of 14–65 at the age of 17 years. Converted into accidents per

100 full-time equivalent workers, this equals: 4.6 accidents at the age of 14 and 3.4 at the age of 17. The most prevalent injuries were contusions, cutting on sharp edges, and strains and sprains (results not shown).

Table III shows the association between the different lifestyle and work environment factors and work accidents. Teenage boys had a larger risk of experiencing a work accident compared to their female peers. The association weakened when adjustment was made for lifestyle and work environment factors, and it disappeared entirely in the stepwise selection procedure used for Model 3. This suggests that the increased risk for boys is caused by a selection into job types where they are more prone to experience accidents.

An association between drinking and work accidents was demonstrated only in the bivariate analysis; however, adolescents smoking on a daily basis were twice as likely to experience a work accident as those who did not smoke or only smoked irregularly.

Being an apprentice increased the risk of experiencing a work accident fivefold and this association persisted even after adjusting for all the other work environment factors. For that very reason, this group is of special interest as a target for preventive action because their increased risk compared with

TABLE II. Prevalence and Incidence of Work Accidents Among Danish Working Adolescents Aged 14 and 17 Years

	2004 (14/15 years)	2007 (17/18 years)
Participants	3,057	2,328
Proportion of working adolescents	66.0%	77.9%
Average hours worked per week	7.54	16
Number of work accidents past year	57	86
Prevalence of working adolescents with a minimum of one work accident	2.8%	4.7%
Incidence per 1 million work hours	89	65
Incidence per 100 full-time equivalent worker	4.6	3.4

other adolescents cannot be explained by the few available work environment indicators included in the present study (i.e., a more hazardous work environment).

Heavy lifting, a psychologically demanding job as well as low social support from management were all associated with an increased risk of experiencing work accidents even when adjusting for all other factors.

A low degree of influence on work tasks, social support form colleagues, time pressure, bullying and dissatisfaction with work all indicated a raised risk of experiencing a work accident, but the association was substantially weakened when adjusting for the other factors.

DISCUSSION

Incidence of Work Accidents Among Adolescents and Young Adults

In this study, the incidence of work accidents was nearly twice as high among adolescents as among the adult Danish work force in terms of incidents per million working hours. This incidence measure should give a rather precise estimate of the incidence because it takes time at risk into account, which is missing when comparing accidents rates on the basis of, for example, number of treatments at emergency departments per 1,000 persons in a selected age group. The number of work accidents in the present study was 89 per million working hours at the age of 14/15 and 65 per million working hours at the age of 17/18.

The multitude of definitions of accidents used in previous studies represents one of several barriers to proper understanding of work accidents among adolescents and to comparison of existing studies. In the present study, we defined an accident as an incident that demanded medical attention. This definition of accidents is more precise than for example absence from work which, when used as a definition, may involve serious underreporting. However, a definition that rests on the criterion of medical attention is also biased by the availability of medical attention and by

personal preferences and thresholds for seeking medical attention. This is, of course, mainly relevant in minor injuries.

Comparison of the figures presented in this study with figures from the national rates of lost time injuries (LTI = at least 1 day off work) gives a difference of 70–230%. The number of work accidents per 100 full-time equivalent workers was 4.6 at the age of 14/15 in this cohort, and 3.4 at the age of 17/18. This figure should be compared with national figures, which show 2.0 accidents for the 18–24-year-olds and 1.2–1.9 for the rest of the workforce (i.e., 25–64-year-olds), depending on age group [The Danish Work Environment Authority, 2009]. The authorities consider that figures form adolescents up to age 18 are non-reliable, presumably due to substantial underreporting. However, the definition of work accidents used in the national system may result in systematic underestimation of the extent of accidents among adolescents and young adults because of their non-standardized participation in the labor market (e.g., by working part-time, on short term contracts, etc.). In other words, this comparison may be imprecise due to the difference in the definition of accidents.

Bearing in mind these differences, it is difficult to compare the results of the present study with existing studies from other countries. However, in their review of the American literature on adolescent work injuries, Runyan and Zakocs [2000] found somewhat higher incidences of work accidents among adolescents than was the case in the present study. Studies based on representative data from emergency departments indicate an incidence of work accidents between 4.7 and 7.0 per 100 full-time equivalent workers depending on the nature of the occupation held [Layne et al., 1994].

The study that resembles the present most is Zierold et al. [2004], which included high school students aged 10–14 years. Among the total study population of 5,464, 2.7% experienced an injury defined as incidents affecting their activities at home, work, or school for at least 3 days. The corresponding injury rate for 15-year-olds in our sample was 2.8%.

TABLE III. Associations Between Work Accidents, Lifestyle, and Work Environment Factors

		Model 1 (Adjusted for working hours only)[a]	Model 2 (Adjusted for working hours and all other variables) (N = 1,610)	Model 3 (Stepwise backwards selection)[b] (N = 1,610)
Gender				
Girls	Ref	1.00	1.00	Removed
Boys		2.10 (1.30–3.39)	1.58 (0.83–3.02)	
Lifestyle factors				
Alcohol consumption				
Consumed alcohol <10 days past month	Ref	1.00	1.00	Removed
Consumed alcohol >10 days past month		1.93 (1.06–3.51)	1.17 (0.56–2.45)	
Smoking				
Does not smoke/smokes occasionally	Ref	1.00	1.00	1.00
Smokes daily		2.70 (1.66–4.38)	2.13 (1.17–3.88)	2.23 (1.25–3.96)
Work environment factors				
Heavy lifting				
No heavy lifting	Ref	1.00	1.00	1.00
Heavy lifting		3.15 (1.75–5.67)	2.13 (1.10-4.11)	2.31 (1.22–4.39)
Psychological demands				
Low psychological demands	Ref	1.00	1.00	1.00
High psychological demands		2.39 (1.31–4.37)	2.42 (1.25–4.68)	2.36 (1.23–4.54)
Social support from management				
Social support from management	Ref	1.00	1.00	1.00
No social support from management		2.10 (1.17–3.75)	1.99 (0.90–4.37)	2.21 (1.16–4.19)
Social support from colleagues				
Social support from colleagues	Ref	1.00	1.00	Removed
No social support from colleagues		1.97 (0.94–4.15)	0.95 (0.37–2.45)	
Decision latitude				
High degree of influence on work tasks	Ref	1.00	1.00	1.00
Low degree of influence on work tasks		1.63 (0.98–2.73)	1.62 (0.90–2.94)	1.72 (0.97–3.03)
Time pressure				
No time pressure	Ref	1.00	1.00	Removed
Time pressure		1.84 (0.94–4.17)	1.10 (0.46–2.65)	
Work satisfaction				
Satisfied with work	Ref	1.00	1.00	Removed
Dissatisfied with work		1.62 (0.88–3.01)	1.27 (0.57–2.82)	
Bullying				
Not bullied	Ref	1.00	1.00	Removed
Bullied at least once during past year		1.94 (0.99–3.80)	1.16 (0.55–2.43)	
Job type				
Spare time job	Ref	1.00	1.00	1.00
Apprentice		7.77 (3.37–17.92)	4.57 (1.88–11.09)	5.36 (2.28–12.62)
Ordinary full-time job		3.71 (1.35–10.23)	2.27 (0.77–6.71)	2.35 (0.81–6.87)
Hosmer–Lemeshow Goodness-of-fit			Chi-square 1.01 (P = 0.06)	Chi-square 560.61 (P = 0.215)
Nagelkerke Pseudo R[b]			0.171	0.165

Logistic regression (95% confidence intervals).

[a]N varies for each independent variable due to missing data.

[b]Number of work hours was kept in the model despite being removed due to a non-significant association with work accidents. This was done in order to take into account the number of hours participants were at risk of experiencing a work accident.

In another, currently unpublished study from our group, we found that during a 4-month period 75–80% of apprentices in the building industry experienced an injury, defined as a work incidence creating a need to interrupt work for a while. If this result is extrapolated to the 300 apprentices of the present study's round 2, where participants were 17 years old, we would see 240 accidents according to this definition—so at least for this group of apprentices, we probably only registered the tip of the iceberg. Driscoll and Hanson [1997] also studied apprentices, and with a definition of injury severity resembling ours, they found that apprentices at the construction and engineering schools had odds ratios (ORs) ranging from 5 to 7 compared with a reference group of apprentices at the Arts and Design School at the same educational institution.

Most reviews of the literature find that age is negatively associated with injury occurrence. In the most recent review of the literature, Salminen [2004] found that the majority of studies reported higher injury risks among young workers than among older workers although the risk of fatal injuries was lower among the former. This is consistent with an analysis based on 900,000 national Canadian compensation cases by Breslin et al. [2003]. This study demonstrated the highest injury rate for 20 to 24-year-old young adults and the second highest rate among 15 to 19-year-old adolescents. The injuries, however, were more severe among adults aged 25+ than among younger workers, and the former were more often permanently impaired by their injuries than the latter. In a review from 1995 on age differences in work injuries^Q3, Laflamme and Menckel [1995] concluded that the direction as well as the magnitude of the relation between aging and occupational accidents reported so far had been inconclusive. They suggested that this ambiguity be rooted in the fact that some types of accidents become less frequent with age because of increased experience with the work tasks generating accidents, while other accidents become more frequent with age because they are more difficult to carry out at older ages. This is consistent with a study by Breslin and Smith [2005] who found that age was not associated with work accidents when job and work place factors were taken into account.

Experience and work environment factors may partly explain the age differences in work accidents. Some researchers have speculated about a third explanation: Do young people have a lower threshold for consulting their doctor in the event of accidents than their adult colleagues? If so, this would lead to overestimation of the number of accidents in this age group compared with the adult population, especially when data are self-reported. This interpretation appears to be consistent with the finding that adolescents suffer more injuries than their older colleagues, even if they are less severe [Breslin et al., 2003]. This may be the case for those participants in our population who were working, for example, in supermarkets and restaurants, even if we have no data supporting this.

The Association Between Work Environment Factors and Work Accidents Among Adolescents

We found that three work environment factors contributed independently to a higher risk of experiencing a work injury at the age of 17/18 when adjusting for other work-related factors, including working hours. Heavy lifting, psychological demands, and lack of support from management all doubled the risk of suffering a work accident.

On some points these findings converge with the very few multivariate studies so far conducted on this age group. Breslin and Smith [2005] found that physical exertion raised the risk and that this association accounted for some of the age differences in injury incidence. However, on a number of issues, our study differs from what has been observed in the literature so far. Some studies have found that work pace is a risk factor [Frone, 1998; Evensen et al., 2000], and while we observed a bivariate association between time pressure and work injuries, this association disappeared when other work environment factors were taken into account. Finally, in contrast to the associations reported by Frone [1998] who found that supervisor monitoring was not associated with injury occurrence, we observed a strong effect of lack of social support from management in our cohort. This confirms earlier hypotheses mentioned in Runyan and Zakoc's literature review (2000) and in a study of injured adolescents in which Knight et al. [1995] found that 25% of those injured had been alone at the time of their accident and that 80% had been without supervision. The inconsistencies between our study and Frone's might be related to differences in the selection of supervisor contact aspects between the two studies. The questions used in this study emphasize a situation in which the respondent needed support to conduct his or her work tasks adequately, whereas Frone tapped into a more general case of supervisor monitoring, which in some cases may be seen as intrusion instead of support from the point of view of the adolescents.

Interestingly, the bivariate analysis indicated an association between work injury and bullying, job influence and work satisfaction even if the associations were marginally insignificant. We interpret this as evidence that these working environment factors are, indeed, related to the occurrence of accidents although they are mediated through the effect of other working environment factors. Thus, for example bullying does not lead to accidents directly, but being bullied at the workplace implies that the subject is assigned to more dangerous work tasks, or perhaps it means that social support from colleagues and management is less available when needed. Psychosocial factors at the workplace are thus of

some importance to the prevention of work accidents among adolescents.

The association found between lack of management support and occurrence of accidents is hardly surprising given that management commitment is generally recognized as the single most important factor for companies' safety performance [Dedobbeleer and Beland, 1991; Simard and Marchand, 1995; O'dea and Flin, 2001; Zohar, 2000]. Furthermore, studies have shown that managerial practices related to building more supportive relationships between workers and managers have an effect on accident occurrence [Zohar, 2002; Barling et al., 2002Q4].

Risks related to specific jobs in specific trades and the level of safety training, are, of course, essential [Sahl et al., 1997], especially in hazardous occupations like the building industry. We found a more than fourfold increased risk for the 17/18-year-old apprentices than for adolescents holding spare time jobs. This association persisted even after adjusting for differences in work environment and for working hours, which indicates that apprentices may be in special need of training and prevention efforts.

Smoking and Alcohol Consumption as Predictors of Work Injuries

We found that alcohol consumption was not associated with an increased risk of work accidents when adjusting for all other variables included in the study. This finding is consistent with Frone [1998] who found that both on-the-job and general substance use were associated with work accidents, but only the former association remained significant when adjusting for the other factors included in the study. Shipp et al. [2005] found that alcohol consumption and binge drinking were both significantly associated with work injuries. In Shipp's study, however, no adjustment was made for the importance of other factors that could explain the difference between her study and ours as well as Frone's.

In our study, smoking on a daily basis was also found to be associated with work accidents, even after adjusting for all other variables. We hypothesize that smoking as a risk marker serves as a proxy for a special group of adolescents who are particularly prone to risk-taking behavior that could result in work accidents.

Strengths and Limitations of the Study

This paper benefits from drawing on data from the West Jutland Cohort Study, a birth cohort which enjoys a high participation rate and a great variety of questions tapping into different areas of adolescent life which makes it possible to perform multivariate analyses of the risk of experiencing work injuries. This particular paper does not deploy a longitudinal design because no information about work environment factors was collected in the first round of questionnaires

at the age of 14/15. However, the development in the incidence of work accidents per million working hours compares the prevalence of accidents with the number of hours worked in the first and second round.

The study, however, also has some limitations. Accidents were relatively few in number, and this could invite type 2 errors, and associations could be overlooked. We used only self-reported accident data, which made it difficult to compare the results of this study with those of other studies on the subject of adolescent work accidents. Combined with the fact that the study mostly focuses on psychosocial factors of importance for social inequalities in health in a life-course perspective, we are unable to give details on injury description. In addition, the physical work environment factors were not covered in detail and there were no questions on exposure to chemical agents at all. Although, we feel confident that the study is representative of adolescents from the Western part of Denmark, we have to take into consideration the limitations in generalizing from this population to adolescents elsewhere. Basically, the working environment in supermarkets, restaurants, and many other sites where adolescents typically work in the Western world will look very much alike. Even for adolescents doing farm work and apprentices in the construction and metal industry, there will be many similarities. In other words, while the incidences presented in this study may differ quite substantially from what would be observed in other settings, for example, in the United States, due among others to differences in legislation, we have no reason to believe that the associations observed between work environment and lifestyle factors would be different in other contexts.

We therefore need to consider what can be done to reduce the high level of work accidents among young people. We found that lack of social support was a separate, important factor. This problem was rooted in attitudes and acts from management rather than from co-workers. As the majority of the working adolescents in this population (>93%) were still attending schools and institutions, these seem to be an obvious setting for educational measures targeted at work environment matters in general, while the undertaking of specific safety instruction and training should be the competence of the work site. From a Danish context, we know that the safety training offered to apprentices, for example, in the construction industry, is insufficient [Pedersen, 2004]. The results from this study should encourage more cohort studies of accidents among adolescents.

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Author Proof

the issue of adolescents' work accidents at an earlier stage in the project.

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