USE OF PERSONAL PROTECTIVE EQUIPMENT AND FACTORS ASSOCIATED WITH INJURIES AMONG VOCATIONAL AND TECHNICAL HIGH SCHOOL STUDENTS

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ABSTRACT

Objective: *In this study, the aim was to investigate the use of personal protective equipment (PPE) and the factors associated with injuries among vocational and industrial high schools in Adana and Mersin.*

Material and Method: *This cross-sectional study included 1742 students who attended high schools in the Adana and Mersin provinces between April and May 2013. The questionnaire was filled out by the students. The study data were evaluated by descriptive statistics, the chi-square test, Student's t-test, the Mann-Whitney U test and binary logistic regression.*

Results: *The study included 1742 students. Among the students, 1530 (87.8%) were male. While 1510 (86.7%) students used at least one PPE, 232 (13.3%) used none at all. In the binary logistic regression model, 10th graders*

(OR 3.80), 11th graders (OR 3.21), monthly income of 434 USD or less (OR 2.69), training for the use of tools/devices (OR 1.96) and the number of risks defined specifically for the department (OR 1.11) were associated with the student's PPE use. Among the participating students, 430 (24.7%) were injured within the past year. In the binary logistic regression model, 10th graders (OR 1.85), 11th graders (OR 2.26), the weekly practical training hours (OR 0.96) and household population (OR 1.10) were associated with the students' injuries.

Conclusion: *In vocational and technical high schools, training on the use of devices and tools, defining the risks and structured trainings on the use of PPE must be considered to protect the students.*

Keywords: *Personal protective equipment, injury, vocational education, schools, students.* **Nobel Med 2017; 13(2): 28-35**

MESLEKİ VE TEKNİK LİSE ÖĞRENCİLERİNDE KİŞİSEL KORUYUCU DONANIM KULLANIMI VE YARALANMA DURUMU İLE İLİŞKİLİ FAKTÖRLER

ÖZET

Amaç: Bu çalışmada, Adana ve Mersin'de mesleki ve teknik liselerde öğrencilerin kişisel koruyucu donanım (KKD) kullanımı ve yaralanma durumu ile ilişkili faktörlerin araştırılması amaçlandı.

Materyal ve Metot: Kesitsel tipte planlanan bu araştırma Nisan ve Mayıs 2013 tarihleri arasında, Adana ve Mersin'de liseye devam eden 1742 öğrencinin katılımıyla yapıldı. Anket formu öğrenciler tarafından dolduruldu. Çalışma verilerinin değerlendirilmesinde tanımlayıcı istatistikler, ki-kare testi, Student t testi, Mann Whitney U Testi ve ikili lojistik regresyon modeli kullanıldı.

Bulgular: Çalışmaya 1742 öğrenci katıldı. Öğrencilerin 1530'u (%87,8) erkekti. Öğrencilerin 1510'u (%86,7) en az bir KKD kullanmakta iken, 232 (%13,3) öğrenci hiçbir KKD kullanmıyordu. İkili lojistik regresyon modelinde öğrencilerin KKD kullanımı ile 10. sınıf (OR 3,80), 11. sınıf (OR 3,21), 434 USD ve daha az aylık gelir (OR 2.69), araç/gereç kullanma eğitimi (OR 1,96) ve bölümle ilgili tanımlanan risk sayısı (OR 1,11) arasında ilişki vardı. Çalışmaya katılan öğrencilerden 430'u (%24,7) son bir yıl içinde yaralanmıştı. İkili lojistik regresyon modelinde öğrencilerin yaralanması ile 10. sınıf (OR 1,85), 11. sınıf (OR 2,26), haftalık atölye saati (OR 0,96) ve hane halkı nüfusu (OR 1,10) arasında ilişki vardı.

Sonuç: Mesleki ve teknik liselerde araç ve gereç kullanma eğitimi, risklerin tanımlanması ve yapılandırılmış KKD kullanımı eğitimi konuları öğrencileri korumak için göz önünde bulundurulmalıdır.

Anahtar kelimeler: Kişisel koruyucu donanım, yaralanma, mesleki eğitim, okullar, öğrenciler. **Nobel Med 2017; 13(2): 28-35**

INTRODUCTION

In 1950, the World Health Organization (WHO) and the International Labor Organization (ILO) defined occupational health as attempts aiming to generate, maintain, and develop the physical, mental, and social well-being of workers from all occupations.[1] The foremost principle of occupational health and safety is control at the source. There are various engineering controls that aim for this target. However, in cases where control at the source cannot be achieved, personal protective equipment (PPE) should be used.[2]

PPE has been defined as "a device, garment or equipment developed to protect the wearer or bearer from one or more safety and health hazards".[3] PPE is designed to protect the worker from serious workplace injuries or chemical, radiological, physical, electrical, mechanical or other workplace hazards as well as from diseases that can transmit by contact.[4] PPE is an instrument that may protect the head, face, eyes, hands, fingers, hearing, respiration, feet, or body as a whole.[2]

According to the results of the European Working Conditions Survey, younger workers were less knowledgeable about the use of materials, equipment and products than were older workers.[5] In addition, because young workers lack experience, are in the development process, and have limited awareness of existing and potential risks, they are reported to be at a high risk of injury at work.[6]

Work accidents and occupational diseases that stem from the workplace environment and that occur during or after work are two leading indicators of occupational health.[2] Young workers may suffer injuries during training in schools also. In studies conducted in the United States, China, Switzerland and Finland, the injury rate within the last year among students is reported to range between 19.7% and 32.3.[7-10] In a study conducted in Kayseri, a province in Turkey, this rate was 29.4%.[11] According to a study in the US, the most common injuries among students were cuts (43.5%) followed by bruises and burns (21.8%).[12] In a study in Turkey, cut, bruise and burn rates were 55.0%, 21.7%, and 7.6%, respectively.[11]

In Turkey, vocational and technical high school students comprised 40% of the total number of students in the 2013-2014 academic year.[13] As in other countries, in Turkey, vocational and technical high school students are exposed to many dangers and risks, and thus, they are more likely to be exposed to injuries during their educational process and practices. School safety in places such as vocational schools, technical training schools, apprenticeship training centers and job training centers is particularly important.[14] It is very important to protect students from possible risks and hazards and to ensure their

safety in school or in places where educational activities are performed.

In this study, the aim was to investigate the use of personal protective equipment and factors associated with injuries among vocational and industrial high schools in Adana and Mersin.

MATERIAL AND METHOD

This cross-sectional study was performed between April 1, 2013 and May 30, 2013 in Adana and Mersin, two provinces where the industry and service sectors are well developed and where a large number of students work in these sectors.[15] The study population consisted of students who attended the vocational and industrial high schools in these two provinces. Before the study was conducted, approvals were obtained from Mersin University Clinical Research Ethics Committee. Related institutional permissions were also obtained from the Provincial Directorates of National Education in Adana and Mersin.

Population and Sample

Because 9th graders of vocational and industrial high schools did not attend any workshops, they were excluded from the study. The study population consisted of 16298 10th, 11th, and 12th graders who attended vocational and industrial high schools in the Adana and Mersin provinces. A multi-stage sampling method was used in this study. The first stage was the selection of schools using stratified cluster sampling. In the second stage, the selection of students was made by systematic sampling. The minimum sample size was calculated to be 1800 students (50% prevalence, 95% confidence interval, ±2-3 margin of error).

After the two provinces were weighted according to the number of students who continued their education in the vocational and technical schools, the number of students from each province for inclusion in the study was determined. Therefore, 720 students from Mersin and 1080 students from Adana were targeted for inclusion in the study. The number of schools was calculated based on the number of students. The six schools from Mersin and 8 schools from Adana for inclusion in the study were selected in a randomized fashion.

Questionnaire

A structured questionnaire was designed by reviewing the pertinent literature.[7-12] There were 3 types of questions: multiple choice, yes/no and fill-in-the-blank. The questionnaire included 12 items that gathered sociodemographic characteristics and 11 items that gathered information on PPE use and injury cases. The participants were asked to write down their parents' occupations, and the "International Standard Classification of Occupations–ISCO 08" was used when the data for the classification of occupations were entered.[16]

The "retired" option was added to the classification of occupations. In the analysis, similar occupations were placed in the same category. The items that gathered the monthly household income were based on the minimum wage in the first six months of 2013 in Turkey, which was $434, and the monthly household income was categorized as ≤$434, $435-$868, and ≥$869.[17]

Variables

While the dependent variables of the study were PPE use and injuries that occurred within the past year, the independent variables were sociodemographic characteristics, the number of people living at home, weekly workshop time, training on the use of devices and tools, the number of identified risks and personal protective equipment use.

Data Collection

The schools were visited on the dates that were agreed upon, and informed consent forms were handed out to the participants' parents. The students who agreed to participate in the study and whose parents approved their participation were included in the study. Eight students or parents from Adana and 18 students or parents from Mersin did not approve participation in the study. Thus, 1774 students (1072 from Adana and 702 from Mersin) were included in the study. Teachers were asked to leave the classrooms during the data collection process. The questionnaires were handed out to the students. While the students filled in the questionnaires, the researchers stayed in the classrooms. The number of 12th graders contacted was low because they were preparing for the university entrance exams during the data collection process and thus most of them were not at school. Thirty-two students who improperly filled out the questionnaires were excluded from the study. Thus, the data obtained from 1742 students were evaluated. The participation rate was 96.7%.

Data Analysis

The data obtained from the study were transferred to a computer. After checking the quality of the data, statistical analysis was performed. To analyze the

data, descriptive statistics such as frequency, standard deviation, minimum, maximum, mean and median were used. Categorical variables were compared by the Pearson chi-square test, while continuous variables were compared by independent samples t-test and the Mann-Whitney U test. Important variables evaluated with one-tailed significance tests were included in the binary logistic regression model to determine PPE use and risk factors for injury. Therefore, the results of the one-tailed analysis are not shown. In the present study, p values < 0.05 were considered statistically significant.

RESULTS

The present study included 1742 students. Among the students, 1530 (87.8%) were male. The students' mean age was 17.3±1.1 years (min: 14; max: 22). The mean number of siblings and the mean household population were 2.9±1.9 and 4.8±1.8, respectively. Other sociodemographic data are shown in Table 1.

The departments and the number and percentages of participating students who received training in those departments were as follows: 420 (24.1%) in electric and electronics, 327 (18.8%) in machine technology, 176 (10.1%) in electric, 164 (9.4%) in motor vehicle technology, 145 (8.3%) in information technology, 106 (6.1%) in installation and air-conditioning technologies, 105 (6.0%) in metal technology, 77 (4.4%) in wood technology, 75 (4.3%) in chemical technology, 47 (2.7%) in biomedical equipment technology, 39 (2.2%) in textile technology, and 20 (1.1%) in industrial automation (Table 2). The mean duration of weekly practical lessons was 15.0±7.3 hours.

Department-related risks comprised hand injuries according to 1107 (63.5%) of the students, electric shocks according to 793 (45.5%), skin injuries according to 685 (39.3%), eye injuries according to 659 (37.8%), noise according to 622 (35.7%), contact with hot items according to 553 (31.7%), foot injuries according to 405 (23.2%), respiratory problems according to 358 (20.6%), falls from height according to 155 (8.9%) and head traumas according to 135 (7.7%) (Table 3). In the present study, 1599 (91.8%) students reported that PPE was available in case hazards and risks might occur during a practical lesson. While 1510 (86.7%) students used at least one PPE, 232 (13.3%) used none at all (Figure). Data on PPE availability and PPE use in the workshops are given in Figure. While 1469 (85.7%) students received training on the use of tools and devices used in the workshop, 246 (14.3%) did not.

Table 1. Sociodemographic characteristics of the participating students		
Variables	**n**	**%**
Gender		
Male	1530	87.8
Female	212	12.2
Grade level		
10th graders	633	36.3
11th graders	632	36.3
12th graders	477	27.4
Father's occupation*		
Artist, technician	546	32.8
Administrators and professionals	139	8.4
Office worker or salesperson	122	7.4
Menial jobs or unemployed	546	32.8
Agricultural workers	95	5.7
Pensioners	215	12.9
Mother's occupation*		
Unemployed	1551	91.5
Other	144	8.5
Father's educational status*		
Primary school or less	172	10.0
Junior high school	820	47.8
High school	336	19.5
University	389	22.7
Mother's educational status*		
Primary school or less	399	23.1
Junior high school	813	47.0
High school	276	16.0
University	240	13.9
Monthly income*		
≤$434	311	21.2
$435-$868	840	57.2
≥$869	318	21.6
Parents		
Alive and together	1587	91.1
Passed away or separate	155	8.9
Total	**1742**	**100.0**

*: The questions left unanswered in the questionnaire were not included in the assessment.

Factors that affect the participating students' PPE use in the study were analyzed with a binary logistic regression model. This analysis revealed that PPE use was 3.8 and 3.21 times higher among 10th and 11th graders than 12th graders, respectively (Table 4). Other variables associated with PPE use are given in Table 4. In this present study, no statistically significant relationship was determined between gender and the use of PPE (p>0.05).

Table 2. The departments of the participating students

Departments	n	%
Electric and electronics	420	24.1
Machine technology	327	18.8
Electric	176	10.1
Motor vehicle technology	164	9.4
Information technology	145	8.3
Installation and air-conditioning technologies	106	6.1
Metal technology	105	6.0
Wood technology	77	4.4
Chemical technology	75	4.3
Biomedical equipment technology	47	2.7
Textile technology	39	2.2
Industrial automation	20	1.1

Table 3. Department-related risks defined by the students

Departments	n	%
Hand injuries	1107	63.5
Electric shocks	793	45.5
Skin injuries	685	39.3
Eye injuries	659	37.8
Noise	622	35.7
Contact with hot items	553	31.7
Foot injuries	405	23.2
Respiratory problems	358	20.6
Falls from height	155	8.9
Head traumas	135	7.7

Table 4. Factors that affected the participating students' PPE use students

Variables	B	OR	95% CI	p
Grade level				
10th graders	1.33	3.80	2.54- 5.69	<0.001
11th graders	1.16	3.21	2.16- 4.76	<0.001
12th graders		1.00		
Monthly income				
≤$434	1.08	2.96	1.72-5.11	<0.001
$435-$868	0.35	1.42	0.98-2.06	>0.05
≥$869		1.00		
Training on the use of devices and tools				
Yes	0.67	1.96	1.31-2.92	=0.001
No		1.00		
Number of risks identified	0.10	1.11	1.02-1.20	<0.05

Binary logistic regression analysis was used.
Constant: -0.73, **B:** regression coefficient, **OR:** odds ratio, **CI:** confidence interval

Among the participating students, 430 (24.7%) were injured within the past year. Among these injured students, 389 (25.4%) were male and 41 (19.3%) were female. The mean injury rate within the past year was 1.3±3.5. There was no statistical difference between male and female students with regard to injury rates ($p > 0.05$).

Factors that affected the injuries among participating students during training within the past year were analyzed with the binary logistic regression model. This analysis revealed that the 10th and 11th graders were 1.85 and 2.26 times more likely to be vulnerable to injuries than the 12th graders, respectively (Table 5). It also revealed that increased workshop hours and larger household population increased the prevalence of injuries 0.96 and 1.1 times, respectively (Table 5).

Among the injured students, 266 (61.9%) were injured in a practical class, 8 (1.9%) were injured in a laboratory, and 156 (36.2%) did not remember the location of the accident.

While 133 (30.9%) of the injured students were using PPE during the accident, 297 (69.1%) either did not use PPE or did not remember whether they used PPE.

DISCUSSION

This study is one of the few epidemiologic studies in the literature that evaluated the use of PPE and the factors associated with injuries. In several pertinent studies, younger workers were reported to be not knowledgeable enough about PPE. In a study conducted in the Netherlands in 2005, 43.6% of the young workers were reported to be not knowledgeable enough about work safety.[18] In a 2004 study conducted in Istanbul, a province in Turkey, it was reported that 34.4% of the students were not sufficiently informed about work safety.[19] However, in the present study, 85.7% of the students received training about the use of related tools/devices, which suggests that an emphasis had been placed on the subject during trainings in vocational and technical schools since that study.

In the present study, more than half of the students considered hand injuries to be department-related risks. Two studies conducted in the US showed that the most commonly injured body parts were fingers and hands (51.6-58%).[12,20] In a study conducted in the Kayseri Vocational Training Center, hands and fingers were reported to be the most injured body parts of the apprentices (58.7%).[11]

In a study conducted in Izmir, another province in Turkey, the factor that affected the use of PPE most was the availability of PPE.[21] In the present study, 91.8% of the students stated that PPE was available in the workshops. In a study conducted in the Kayseri province, among the apprentices, 44.3% used PPE, 39.4% did not use PPE and 16.3% considered PPE use to be unnecessary.[11] However, in the present study, it was found that 86.7% of the students used PPE, which can be explained by the fact that there was enough PPE in the schools where this study was carried out and that adequate training on the use of PPE was provided in these schools.

A study conducted in the United States determined that PPE use decreased as age increased.[12] It is noteworthy that a similar result was found in the present study: the higher a student's year in school was, the lower his or her PPE use was. Logic demands that over the years, risk awareness should increase, and thus, PPE should be used more. However, in reality, the opposite occurs: PPE use decreased as the years in school increased, which can be explained by the fact that adolescents feel more self-confident as their years in education increase.

In a study conducted in China, the use of masks was 1.9 times higher among low-income workers.[22] In the present study, low monthly income increased the use of PPE 2.9 times. The students who received training on PPE use had increased the PPE use, which demonstrates the importance of training provided on PPE use.

A study carried out in Nepal reported that as awareness increased, so did PPE use.[23] However, a study conducted in England determined a negative correlation between the perception of risk and PPE use.[24] In the present study, as the number of risks identified increased, so did the use of PPE. Therefore, the increase in risk awareness can be said to have caused an increase in the use of PPE.

Recent foreign studies showed that injury rates among students within the past year range between 19.7% and 32.3%.[7-10] In two studies conducted in Kayseri and Istanbul, 29.4% and 16% of the students, respectively, reported sustaining injuries.[11,19] In the present study, the injury rate within the past year was 24.7%. Both the results of other studies and that of the present study suggest that injuries sustained during practical training are a public health issue among students in vocational and industrial high schools.

Table 5. Factors that affected the injuries among the participating students

Variables	B	OR	95% CI	p
Grade level				
10th graders	0.61	1.85	1.33 - 2.59	<0.001
11th graders	0.81	2.26	1.65 - 3.10	<0.001
12th graders		1.00		
Weekly practical training hours	-0.03	0.96	0.94 - 0.98	=0.001
Household population	0.10	1.10	1.04 - 1.17	=0.001

Binary logistic regression analysis was used.
Constant: -1.671, **B:** regression coefficient, **OR:** odds ratio, **CI:** confidence interval

In the literature, injury rates are higher in male students than in female students.[7,9,10,25] Injury rates are reported to range between 19.4% and 40.0% in male students and between 15.3% and 30.3% in female students.[7,9,10,25,26] In the present study, almost 1/4 of the male students and nearly 1/5 of the female students were injured; however, the relationship betwee gender and injury was not significant. This may be associated with methodological differences and distribution variations of girls and boys in school departments.

Studies in Canada and China report that increasing age is correlated with declining injury rates.[7,27] In the present study, the fact that the 10th and 11th graders were exposed to injuries more than the 12th graders can be explained by the younger students' lack of experience.

A study conducted on young workers in Canada showed that increased work hours were inversely correlated with injury rates.[27] In the present study, the frequency of injuries decreased as their weekly practical training hours increased, which suggests that the students gained experience as the length of their workshop training increased; thus, they were injured less.

In the present study, a larger household population was determined to increase injury rates among the students. This suggests that the perception of risk may be low in large families.

Studies conducted in the US report that in 40.8-44.7% of the injury cases, students used PPE.[12,20] In the present study, 30.9% of the students used PPE when they were injured.

These results indicate that those who used PPE were injured less. On the other hand, the students who were injured even when they used PPE may have used PPE inappropriately for the existing risks or used the PPE inappropriately or irregularly.
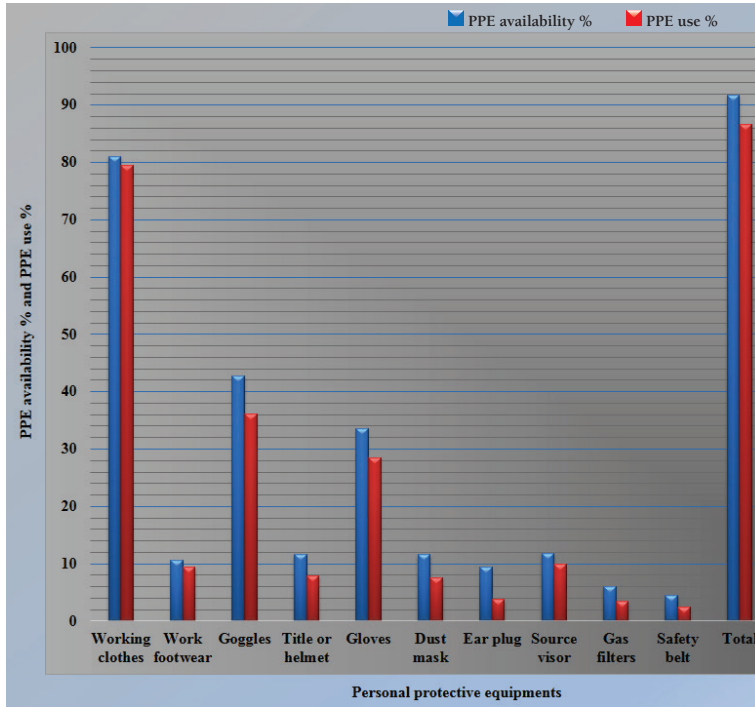
Figure. PPE availability (%) and PPE use (%) in the workshops

CONCLUSION

The results of the present study demonstrated that one-fourth of the participating students were exposed to injuries even though the schools had enough PPE, that the rate of PPE use was high and that the tendency to use PPE was high among the students. Interestingly, although the 10th and 11th graders used PPE more than the 12th graders did, they were subjected to injuries more often. These results show that injuries in schools occurred not due to the lack of PPE but due to the inappropriate use of PPE.

In the present study, the use of PPE was higher among those whose monthly income was low and who attended training on the use of devices and tools. The use of PPE also increased as the number of identified risks increased. Therefore, topics that defined risks and ensured the selection and use of appropriate PPE should be added to the curricula. It is recommended that the structured training on the use of PPE that is given in workshops should be in the form of an applied training.

In the present study, the prevalence of injuries was higher among the 10th and 11th graders and among the students with larger families; however, it decreased as the weekly practical training hours increased. Therefore, it should be taken into account that students who live in larger families, who are in lower grades and whose weekly practical training hours are low are in the at-risk group.

To reduce the number of injuries and to encourage PPE use in vocational and technical schools, it is recommended that appropriate policies and legislation should be developed and awareness should be raised.

Limitations of the present study

Because there was no data on department-specific risks and PPE in the schools, we were not able to conduct an analysis to find out which departments needed what types of PPE.

*The authors declare that there are no conflicts of interest.

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✔ **DELIVERING DATE:** 21 / 04 / 2016 • **ACCEPTED DATE:** 26 / 07 / 2016

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