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Incidence and Risk Factors of Upper Extremity Injuries in Young Adult Men: A Nationwide Registry-Based Study of 128,714 Conscripts

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KEY WORDS: military service, upper extremity injuries, epidemiology, cohort, exemption of duty

ABSTRACT

Introduction: Injuries are the major cause of morbidity and loss of active training days in military populations. Previous investigations have mainly focused on lower extremities. This study evaluated the incidence, diagnosis and risk factors of upper extremity injuries requiring hospitalization in a large cohort of Finnish conscripts during a 5-year period.

Materials and Methods: A total of 128,714 male military conscripts, who served 6-12 months in compulsory military service, were studied. Injury hospitalization data was obtained from the National Hospital Discharge Register. The main outcome variables were hospitalization due to any injuries to the upper extremity and hospitalization due to traumatic shoulder dislocation. Background variables for risk factor analysis included length of military service, age, body height and weight, body mass index and physical fitness.

Results: Overall person-based incidence rate for hospitalization due to upper extremity injury was 743 (95% confidence interval [CI]: 697-791) per 100,000 conscripts per year. Shoulder joint dislocation was the most common injury: incidence rate of 103 (95% CI: 86-122) per 100,000 conscripts per year. Trend during follow-up years 1998-2002 was decreasing concerning on any upper extremity injuries (OR 0.90; 95% CI 0.86-0.95, $p<0.001$). BMI >25 increased a risk for any injuries of the upper extremity (OR 1.29; CI 95%: 1.10-1.51) and, especially, for shoulder joint dislocation (OR 1.88; CI 95%: 1.26-2.80).

Conclusions: Overweight young men were at greater risk for upper extremity injuries. The incidence rate of traumatic shoulder joint dislocation was considerably higher than reported previously. In conclusion, preventive measures such as reducing the body weight of overweight young men should play an important role in reducing the incidence of upper extremity injuries.

INTRODUCTION

Injuries are common in young, active populations. Exercise- and sports-related injuries occur widely in a population of healthy, physically active adults such as military service members.[1] Mattila et al.[2] studied the incidence and risk factors of all injuries among Finnish conscripts and reported that the most common injuries are strains, sprains, and joint dislocations. Military service requires high amounts of physical training, exposing the lower extremities in particular to prolonged physical stress.[3] The first 8 weeks consists of basic training, which requires walking and running, marching, bicycling, and other physical activities. During the 4 months following the basic training period, the amount of physical training is maintained at the same level. Thus, during the first 6 months of military service, conscripts are expected to complete a total of 900 hours of instructed physical training, including military- and sport related physical training and other military activities.[4]

Previously published studies involving military populations have focused mainly on the lower extremities and according to these earlier investigations, most injuries involve the lower limbs.[2,5,6,7] The previously published studies on military conscripts have also demonstrated that sustained physical stress typically causes back injuries, repetitive strain injuries, and stress fractures of the lower limbs. Moreover, during the field exercise, significant changes in hormone percentages of the conscripts has been detected.[8] Taanila et al.[9] reported that overstress causes 77% of lower extremity injuries and 81% of back injuries, but only 44% of upper extremity injuries. In military personnel, injuries are the major cause of morbidity and loss of active training days.[1,2]

In the general population, being overweight is reported to be a significant risk factor for musculoskeletal injuries.[2,9,10] Contrasting data exist regarding risk factors for injuries, Mattila et al.[2] found that good overall physical fitness increases the risk for injuries and good aerobic fitness increases the risk for injuries in the lower extremities while Taanila et al.[9,11] found that low physical fitness and low aerobic fitness increase the risk of injury during military service.

Previous reports in Finnish conscripts indicate that upper extremity injuries comprise almost 20% of all injury-related hospitalizations.[2,5] Some studies have evaluated the incidence of upper extremity injuries in non-military populations. Ootes et al.[12] reported that the overall incidence of upper extremity injuries in American civilians is 1,130 per 100,000 person years.

Polinder et al.[13] reported that the incidence of upper extremity injuries in Dutch civilians increased from 970 to 1098 per 100,000 person years between the years of 1986 and 2008. Larsen et al.[14] studied the incidence of upper extremity injuries among Danish and Dutch civilians, but only injuries of the wrist, hand, and fingers were included in the study, and risk factors apart from age were not evaluated. The incidence of injuries was highest among 10 to 14-year-old boys, but also among young adult males.

The incidence and risk factors of upper extremity injuries requiring hospitalization of young adult men have, however, not previously been evaluated. Therefore, the purpose of the present study was to evaluate the incidence and risk factors of upper extremity injuries in young males during their compulsory military service.

MATERIALS AND METHODS

Study sample

Our study population was comprised of all Finnish male conscripts aged 18 to 30 years performing military service between the years of 1998 and 2002. All Finnish males over 18 years of age are obligated to perform their military service, and approximately 80% carry out their full service period. In the present study, every conscript was taken into account, whether or not they completed their service period. The main reasons for exemption from military service are chronic diseases, such as diabetes, asthma, and mental health problems. During the 5-year study period, the total number of male conscripts starting their military service was 128,714. The duration of the military service period is 180 days (rank-and-file duties), 270 days (conscripts trained for work requiring special skills), or 362 days (officers and conscripts trained for particularly demanding duties). Approval to use the hospitalization data was granted by the Institutional Review Board of the Ministry of Social Affairs and Health. However, because the current study was based on register data and no clinical patients were enrolled, informed consent of the patients was not required. Thus, the ethical statement for the present study was not needed. Moreover, all data were fully anonymized before we accessed and statistically analysed them.

Study design

Only the first injury leading to hospitalization was included in the present analysis. The injury data were retrospectively obtained from the Finnish National Hospital Discharge Register (NHDR). Finnish conscripts are obliged to use the services of the primary military health care units in the garrisons and Central Military Hospital during their military service period when in need of medical treatment.[15,16] For this reason, the NHDR database reliably contains information about all injuries or other situations resulting in interruption of daily military service. With more details, the NHDR contains information of all conscripts admitted to military hospitals for the treatment of trauma, including the diagnosis, cause of injury, length of hospitalization, age, and domicile of the patient. All visits by conscripts to a military hospital with the ICD-10 (International Classification of Diseases) diagnostic codes of an upper extremity injury were recorded. To ensure that data for only upper extremity injuries were obtained, we used diagnosis codes S14.3 (injury of brachial plexus) and S40.0-S69.9 of the 10th (1996-1999: ICD-10) revision of the International Classification of Diseases.[17] These diagnostic codes include all severe as well as all minor traumatic injuries of the upper extremity. For the present study, a computer search was conducted using these ICD-10 diagnostic codes.

Diagnosis

Fractures of any bone of the upper extremity were first analyzed with all fracture diagnoses together, then in three different categories based on anatomic location. The categories were 1) fractures of the upper arm and shoulder, 2) fractures of the forearm and elbow, and 3) fractures of the hand and fingers. Shoulder joint dislocation caused by a trauma was included in the analysis, while non-traumatic shoulder joint dislocations were excluded.

Physical fitness

Since 1997, information on conscript background variables has been collected and stored in a computer database of the Finnish Defense Forces. The data included the age, body height and weight, and physical fitness. Aerobic fitness was measured using a 12-min running test. Muscle fitness was assessed via determining the number of push-ups, sit-ups, and pull-ups performed in one minute, standing long jump, and a time for maintaining back extension of each individual conscript. Physical fitness was measured during the second week of service.

The aerobic fitness measurement was based on the 12-min run test results which were divided in four categories for men: <2200 m (poor), 2200-2599 m (satisfactory), 2600-2999 m (good), and ≥ 3000 m (excellent). Body mass index (BMI) values were also calculated as the body mass was divided by the square of the height. A report from the World Health Organization Consultation on Obesity defined four BMI-based categories of underweight, normal weight, overweight and obesity.[18] According to World Health Organization´s classification, the conscripts were assigned in the following categories: BMI<18.5 kg/m^2, BMI from 18.5 to 25 kg/m^2, 25 to 30 kg/m^2, and >30 kg/m^2.

Statistical analysis

Risk factor analyses were performed with a logistic regression model. The main outcome variables were 1) hospitalization due to any injuries to the upper extremity and 2) hospitalization due to traumatic shoulder dislocation (ICD-10 diagnosis code S43.0). Additionally, hospitalization due to the 3) upper extremity, 4) hand and fingers, 5) shoulder and arm, and due to 6) the elbow and forearm were modelled. Risk factors analyzed were the length of military service, age, height, weight, BMI, and physical fitness. Due to the correlation between body height and weight, and BMI, only BMI was modelled in multivariable models.

The incidence rate for traumatic injury of an upper extremity was calculated by dividing the number of conscripts with an upper extremity injury by the total number of conscripts. Also, the corresponding 95% confidence intervals (CIs) for incidence were calculated. The incidence rates were presented per 100,000 conscripts.

Associated factors for overweight (BMI≥25), which proved to be significant risk factor for several injuries in the upper extremity, were tested using Pearson chi-square test and multivariable logistic regression analysis.

All risk factors were each included one by one into the logistic regression model as univariable factors. Final multivariable models were performed as entering all variables simultaneously into the model. Additionally, multivariable multivariate analysis was performed for injuries of the shoulder dislocation, upper extremity and, hand and fingers. For every risk factor, the odds ratios (OR) were calculated with a 95% confidence intervals (CI). IBM SPSS Statistics version 23.0 for Windows software (SPSS Inc. Chicago, Illinois) and Stata SE/15.1 for Windows (StataCorp LLC, Texas) was used for statistical analysis.

RESULTS

The overall study population of 128,714 male conscripts was analyzed. A total of 956 men with acute traumatic upper extremity injuries, were hospitalized during the 5-year study period. Thus, 0.7% (956/128714) of all conscripts sustained an upper extremity injury leading to hospitalization. Of these 956 patients, 27% had two or more hospitalization periods. The total number of upper extremity injury hospitalizations was 1733. The total time spent in hospitals was 3843 days, and the median length of hospital stay was 2 days (interquartile range 1-3; range 1 - 21). The mean age of the patients was 20 years (interquartile range 19 - 20).

Because of an upper limb injury, 275 (0.2% of all and 22% of the injured) conscripts had to abort military service, 20 of them permanently and 255 for a given time period. The most common diagnosis (n=132, 13.8% of the conscripts with an upper extremity injury) was traumatic shoulder joint dislocation (ICD-10 code S43.0, see Table I), which also led to the greatest number of treatment periods and cessations of military service (14 cases). Thus, 14/132 (11%) of conscripts with an acute shoulder joint dislocation had to abort their military service, and shoulder joint dislocations caused 20% of all cessations. Also, fractures were among the most typical injuries, with fractures of the metacarpal bones being the most common (Table I).

The individual-based incidence of primary traumatic upper extremity injury during the study period was 743 (95% confidence interval [CI]: 697-791 per 100,000 conscripts). For the most common injury, shoulder joint dislocation, the incidence in men was 103 (95% CI: 86-122 per 100,000 conscripts. Trend during follow-up years 1998-2002 was decreasing concerning on any injuries (OR 0.90; 95% CI 0.86-0.95, $p<0.001$), shoulder joint dislocations (OR 0.82; 95% CI 0.74-0.97, $p=0.019$) and hand and fingers (OR 0.89; 95% CI 0.79-0.99, $p=0.030$) and tendency to decrease in upper extremity injuries (OR 0.92; 95% CI 0.85-1.01, $p=0.068$) in multivariable adjusted (age, BMI, aerobic and muscle fitness, length of military service) models (Fig. 1).

Multivariable risk factor analysis (Table II) revealed that BMI >25 increased a risk for any injuries of the upper extremity (OR 1.29; CI 95%: 1.10-1.51) and, especially, for shoulder joint dislocation (OR 1.88; CI 95%: 1.26-2.80). The longest, one-year length of military service and age of at least 21 years compared to youngest conscripts predicted injuries. Length of the military service increased especially the risk for shoulder and arm injuries. Incidence of the hand and finger injuries were decreased during the follow-up period and among those conscripts, who were in the poorer muscle fitness while increasing trend was seen in older conscripts compared to younger ones (Table II). None of risk factors predicted injuries of the elbow and forearm.

Over-weighted (BMI≥25) conscripts were statistically significantly older, in poorer condition according to both aerobic and muscle fitness (Table III). The obesity seemed to rise year by year during the study period 1998-2002. The shoulder injuries decreased during study period 1998-2002 among normal weight conscripts (OR 0.77; 95% CI 0.65-0.91, p=0.002), but not among over-weighted conscripts (OR 1.09; 95% CI 0.85-1.39, p=0.510) in age, length of military service and aerobic and muscle fitness adjusted multivariable model. In multivariable multivariate regression analysis, when modelling together shoulder dislocation, upper extremity, and hand and fingers, overall model (p=0.044) and shoulder dislocation (p=0.009) reached statistical significance, but not upper extremity (p=0.100) nor hand and fingers (p=0.108).

In addition, over 65 kilograms body weight was a crude risk factor for any injuries (OR 1.33; 95% CI 1.15-1.55). Nevertheless, body height, and physical fitness (aerobic and muscle fitness) were not significantly associated with a risk for hospitalization due to upper extremity injury.

DISCUSSION

The main findings of the present study demonstrate that being overweight (BMI>25) was a statistically significant risk factor for upper extremity injuries, in general, and also for traumatic shoulder joint dislocation. To the knowledge of the present authors, the aforementioned finding of being overweight as an important risk factor has not been reported in earlier literature. Thus, in the future, the high incidence of upper extremity injuries and traumatic shoulder joint dislocation could be prevented by enhancing measures that diminish body weight of overweight conscripts before they start the military service, especially in the countries with compulsory military service.

In the present study, a total incidence of upper extremity injuries requiring hospitalization was 743 (95% CI: 697-791) per 100,000 person years. Previously, Ootes et al.[12] reported an incidence of all upper extremity injuries of 1130 per 100,000 person years, and Polinder et al.[13] reported an incidence of all upper extremity injuries between 970 and 1098 per 100,000 person years. While the incidence is consistent with our results, the comparability with our study is limited because these studies included people of all ages. In addition, their studies were performed in open health care systems. Giustini et al.[19] reported an incidence of upper extremity injuries of 2491 per 100,000 person years based on visits in emergency departments and an incidence of injury leading to hospitalization of 340 per 100,000 person years in Italy. Our study population consisted of young adult conscripts who formed a representative sample of Finnish young men performing their compulsory military service. Thus, our study population is different from the aforementioned previous studies.

In the present study, the most common injury was shoulder joint dislocation, with an incidence of 103 (95% CI: 86-122) per 100,000 person years. In our study, the reported incidence of shoulder joint dislocation was significantly higher than that reported previously for civilian populations[20-26] (Table IV). Zacchilli and Owens[23], however, reported that the incidence of shoulder joint dislocation among 20 to 29-year-old males in the U.S. is 47.8 per 100,000 person years, whereas Liavaag et al.[24] reported that the incidence among 20- to 29-year old Norwegian males is as high as 204 per 100,000 person years.

In a previous study of U.S. military soldiers by Owens et al.[27], the reported incidence of shoulder joint dislocations was consistent with that in our study. These results are comparable in many ways. That study was also performed in closed healthcare systems, i.e., every person with an acute upper extremity injury had to use specific hospitals and healthcare centers. In other studies with military populations, the incidence of shoulder joint dislocations is reported to be even higher.[28-30] Amako et al.[29] reported an incidence of 410 per 100,000 person years among Japanese military cadets, Kardouni et al.[30] reported an incidence of 313 per 100,000 person years among U.S. military soldiers, and Owens et al.[28] reported an incidence of shoulder joint dislocation as high as 435 per 100,000 person years among U.S. military cadets.

Being overweight appears to be a significant risk factor for upper extremity injuries, which is consistent with previous studies of military populations in which risk factors for musculoskeletal injuries in general were evaluated.[2,9,10] Previous studies have shown that shoulder joint dislocations are most common among young males.[20,21,23,26,28,30] To the best of our knowledge, modifiable risk factors (i.e., physical fitness, overweight) for upper extremity injuries, in general, as well as for shoulder joint dislocation, in particular, have not been previously evaluated as comprehensively as in the present study. The present finding emphasized, especially, that being overweight is also a significant risk factor for shoulder joint dislocation.

According to the findings of the present study physical fitness (aerobic and muscle fitness) were not significantly associated with a risk for hospitalization due to upper extremity injury. In the previous literature, low levels of physical fitness have been reported as a predictor for overall musculoskeletal injuries during intensive physical training during the Finnish compulsory military service.[31] However, in contrast to our findings, the previous study included all musculoskeletal injuries while this investigation focused on upper extremity injuries.

A major strength of the present study is that the incidence of upper extremity injuries was evaluated in a large number (128,714) of young men. The data were collected from the NHDR database, whose accuracy and reliability has been reported to be excellent.[15,16] Only injuries severe enough to require hospitalization were included in the study. Because of these factors, every upper extremity injury requiring hospitalization was included in the study with high certainty. In addition, as military service is compulsory in Finland, the study population is highly representative of general young and healthy Finnish males. The incidence and risk factors of upper extremity injuries has been evaluated in a few previous studies, but different confounding factors have not been studied earlier as extensively as in the present study.

While the representativeness and reliability of the study are important strengths, the present study also has some weaknesses. Physical fitness, height, and weight were only measured during the second week of military service. It is possible that there were changes in their values within the study period. In addition, because the military service is usually carried out from 18 to 20 years of age, the results are generalizable only to young and healthy adult males. During the study period, approximately 700 to 800 out of 128,714 conscripts were exempted from military service, usually due to chronic disease. Probably, these dropouts do not affect our results and conclusions.

CONCLUSIONS

Upper extremity injuries are quite common among young men in military environment. Traumatic shoulder dislocations occur more frequently during compulsory military service than in the civilian population. Furthermore, being classified as overweight (BMI > 25), the risk for upper extremity injuries increases. Because military service is compulsory in some countries, the high incidence of shoulder joint dislocation could be prevented by reducing body weight of overweight conscripts. Further studies could clarify trauma mechanisms and other reasons for the injuries and, thus, find out preventive measures.

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FIGURE LEGENDS

Figure 1. Trends of the upper extremity injuries during follow-up 1998-2002.

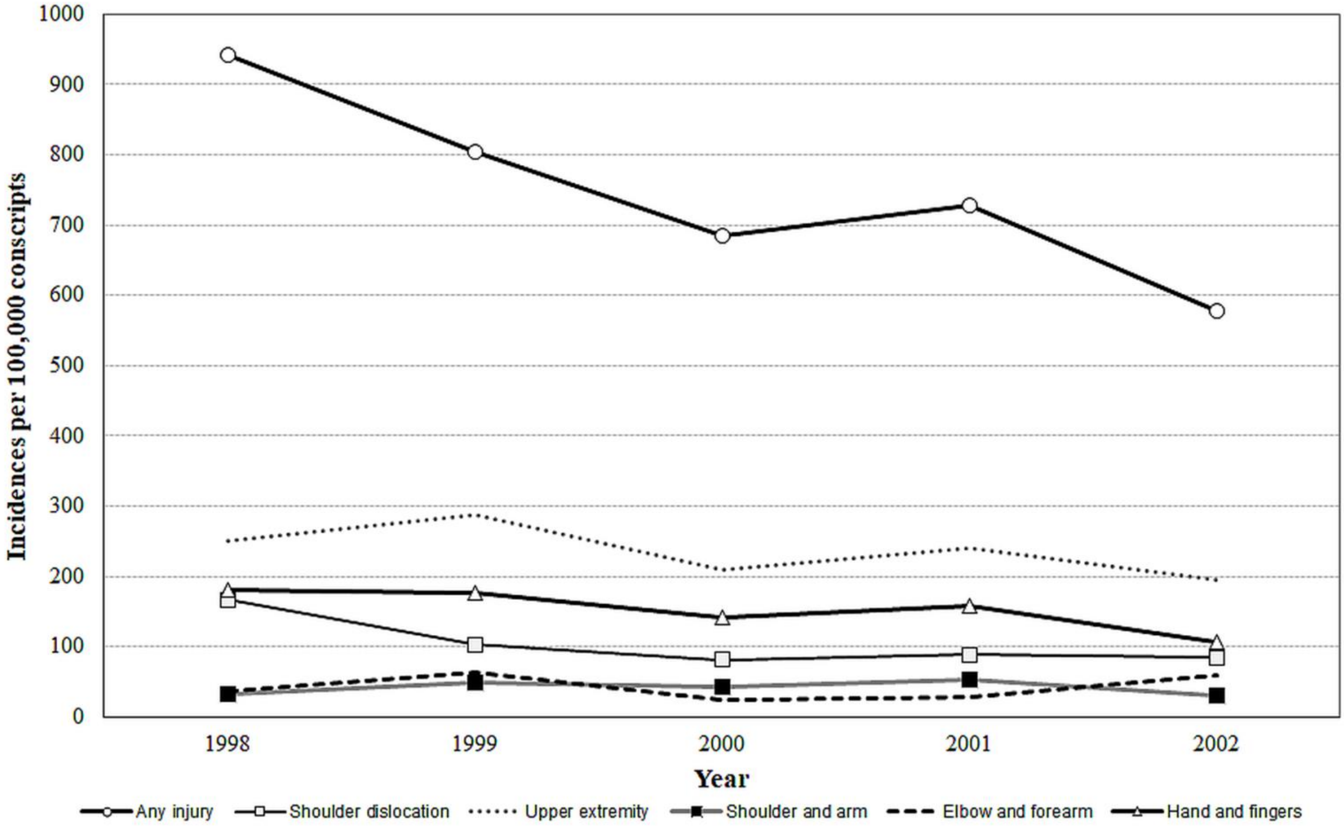

Table I. Acute traumatic upper extremity injuries of Finnish men conscripts from 1998 through 2002 (N=128,714)

	Diagnosis		Hospital readmission	Service class change
Main diagnosis	n	(%)	%	%
Dislocation of shoulder joint (S43.0)	132	(13.8)	43	11
Fracture of other metacarpal bone (S62.3)	94	(9.8)	20	9
Open wound of finger(s) without damage to nail (S61.0)	54	(5.6)	12	0
Contusion of shoulder and upper arm (S40.0)	42	(4.4)	21	5
Fracture of other finger than thumb (S62.6)	44	(4.6)	31	2
Fracture of clavicle (S42.0)	32	(3.3)	25	9
Fracture of lower end of radius (S52.5)	28	(2.9)	27	18
Sprain and strain of shoulder joint (S43.4)	33	(3.5)	24	0
Contusion of other parts of wrist and hand (S60.2)	28	(2.9)	3	4
Fracture of navicular (scaphoid) bone of hand (S62.0)	26	(2.7)	36	2
Dislocation of acromioclavicular joint (S43.1)	23	(2.4)	42	9
Contusion of elbow (S50.0.)	17	(1.8)	8	0
Sprain and strain of finger(s) (S63.6)	17	(1.8)	26	0
Fracture of first metacarpal bone (S62.2)	14	(1.5)	29	0
Other	372	(38.9)	26	7
Total	**956**	**(100.0)**	**27**	**7**

Table II. Risk factor analysis of upper extremity injuries and shoulder joint dislocations (N=128,714)

		Any injuries to the upper extremity (n=956)					Shoulder dislocation (n=132)					Upper extremity (n=305)				
	N	n	Per 100,000	OR	Multivariable (95% CI)	p	n	Per 100,000	OR	Multivariable (95% CI)	p	n	Per 100,000	OR	Multivariable (95% CI)	p
Year																
1998	21,529	203	943	1.00			36	167	1.00			54	251	1.00		
1999	27,095	218	805	0.87	(0.70-1.06)	0.166	28	103	0.64	(0.37-1.05)	0.077	78	288	1.10	(0.76-1.59)	0.599
2000	28,198	193	684	**0.73**	**(0.59-0.90)**	**0.003**	23	82	**0.49**	**(0.28-0.85)**	**0.011**	59	209	0.79	(0.54-1.16)	0.234
2001	28,315	206	728	**0.77**	**(0.63-0.95)**	**0.015**	25	88	**0.53**	**(0.31-0.91)**	**0.020**	68	240	0.91	(0.63-1.33)	0.631
2002	23,577	136	577	**0.61**	**(0.49-0.77)**	**<0.001**	20	85	**0.51**	**(0.28-0.90)**	**0.020**	46	195	0.75	(0.49-1.13)	0.165
Length of military service, days																
180	61,453	396	644	1.00			56	91	1.00			129	210	1.00		
240	4,231	36	851	1.04	(0.71-1.51)	0.848	6	142	0.92	(0.37-2.29)	0.848	7	165	0.73	(0.32-1.65)	0.453
362	63,030	524	831	**1.22**	**(1.07-1.40)**	**0.004**	70	111	1.07	(0.74-1.55)	0.724	169	268	**1.23**	**(0.97-1.57)**	**0.090**
Age, years																
≤19	44,708	314	702	1.00			38	85	1.00			101	226	1.00		
20	67,401	501	743	1.07	(0.93-1.24)	0.335	72	107	1.28	(0.86-1.90)	0.221	158	234	1.04	(0.81-1.34)	0.738
≥21	16,605	141	849	**1.28**	**(1.05-1.57)**	**0.016**	22	132	**1.62**	**(0.95-2.75)**	**0.077**	48	289	**1.40**	**(0.99-1.98)**	**0.060**
BMI, kg/m²																
<25	98,332	703	715	1.00			90	92	1.00			235	239	1.00		
≥25	26,644	230	863	**1.29**	**(1.10-1.51)**	**0.002**	40	150	**1.88**	**(1.26-2.80)**	**0.002**	63	236	1.01	(0.75-1.36)	0.942
Unknown	3,738	23	615	0.95	(0.62-1.44)	0.794	2	54	0.62	(0.15-2.56)	0.512	7	187	0.86	(0.40-1.84)	0.697
Aerobic fitness																
Unknown	18,835	111	589	0.73	(0.48-1.12)	0.153	18	96	0.83	(0.27-2.49)	0.736	30	159	0.52	(0.25-1.10)	0.089
Poor	15,251	110	721	1.12	(0.74-1.69)	0.600	15	98	1.04	(0.34-3.20)	0.947	39	256	1.26	(0.62-2.52)	0.522
Satisfactory	45,581	349	766	1.10	(0.79-1.54)	0.575	36	79	1.05	(0.43-2.61)	0.911	117	257	1.08	(0.61-1.90)	0.794
Good	38,478	304	790	1.06	(0.79-1.44)	0.691	52	135	1.64	(0.75-3.59)	0.213	87	226	0.83	(0.50-1.38)	0.462
Excellent	10,569	82	776	1.00			11	104	1.00			32	303	1.00		
Muscle fitness																
Unknown	22,759	155	681	1.05	(0.71-1.56)	0.810	25	110	0.86	(0.33-2.22)	0.750	47	207	1.07	(0.54-2.12)	0.841
Poor	16,125	105	651	0.74	(0.49-1.12)	0.156	16	99	0.65	(0.23-1.82)	0.412	34	211	0.64	(0.31-1.31)	0.222
Satisfactory	41,578	311	748	0.89	(0.63-1.24)	0.478	32	77	0.53	(0.23-1.21)	0.130	99	217	0.78	(0.43-1.40)	0.400
Good	37,670	300	796	0.96	(0.71-1.30)	0.799	44	117	0.68	(0.33-1.38)	0.281	94	250	0.92	(0.55-1.54)	0.749
Excellent	10,582	85	803	1.00			15	142	1.00			31	293	1.00		

		Hand and fingers (n=197)					Shoulder and arm (n=54)					Elbow and forearm (n=54)				
	N	n	Per 100,000	OR	Multivariable (95% CI)	p	n	Per 100,000	OR	Multivariable (95% CI)	p	n	Per 100,000	OR	Multivariable (95% CI)	p
Year																
1998	21,529	39	181	1.00			7	33	1.00			8	37	1.00		
1999	27,095	48	177	0.94	(0.60-1.48)	0.799	13	48	1.37	(0.54-3.47)	0.507	17	63	1.59	(0.65-3.86)	0.307
2000	28,198	40	142	0.75	(0.47-1.19)	0.746	12	43	1.20	(0.47-3.07)	0.708	7	25	0.62	(0.22-1.78)	0.373
2001	28,315	45	159	0.84	(0.53-1.32)	0.838	15	53	1.50	(0.60-3.72)	0.384	8	28	0.72	(0.26-1.99)	0.521
2002	23,577	25	106	**0.56**	**(0.33-0.95)**	**0.031**	7	30	0.87	(0.30-2.52)	0.801	14	59	1.50	(0.60-3.77)	0.385
Length of military service, days																
180	61,453	97	158	1.00			19	31	1.00			23	37	1.00		
240	4,231	6	142	0.84	(0.34-2.04)	0.692	0	0	-	(-)		1	24	0.65	(0.08-5.53)	0.697
362	63,030	104	165	1.11	(0.82-1.49)	0.508	35	56	**1.81**	**(1.01-3.26)**	**0.048**	30	48	1.24	(0.70-2.18)	0.464
Age, years																
≤19	44,708	62	139	1.00			22	49	1.00			17	38	1.00		
20	67,401	103	153	1.13	(0.82-1.55)	0.454	25	37	0.77	(0.43-1.37)	0.371	28	42	1.09	(0.59-2.00)	0.778
≥21	16,605	32	193	**1.50**	**(0.98-2.32)**	**0.064**	7	42	0.94	(0.40-2.23)	0.891	9	54	1.59	(0.70-3.61)	0.264
BMI, kg/m²																
<25	98,332	150	153	1.00			42	43	1.00			43	44	1.00		
≥25	26,644	43	161	1.06	(0.74-1.52)	0.747	10	38	0.99	(0.48-2.04)	0.977	10	38	0.86	(0.42-1.78)	0.682
Unknown	3,738	4	107	0.77	(0.28-2.09)	0.605	2	54	1.44	(0.34-6.05)	0.620	1	27	0.66	(0.09-4.83)	0.680
Aerobic fitness																
Unknown	18,835	19	101	0.59	(0.23-1.50)	0.266	6	32	0.53	(0.10-2.96)	0.472	5	27	0.40	(0.07-2.41)	0.318
Poor	15,251	28	184	1.93	(0.81-4.59)	0.136	5	33	0.87	(0.16-4.80)	0.877	6	39	0.37	(0.07-1.94)	0.239
Satisfactory	45,581	78	171	1.45	(0.71-2.97)	0.313	18	39	0.77	(0.21-2.90)	0.702	21	46	0.52	(0.14-1.93)	0.331
Good	38,478	52	135	0.90	(0.47-1.72)	0.746	20	52	0.91	(0.28-2.96)	0.868	15	39	0.55	(0.17-1.75)	0.311
Excellent	10,569	20	189	1.00			5	47	1.00			7	66	1.00		
Muscle fitness																
Unknown	22,759	32	141	0.86	(0.37-1.99)	0.729	9	40	2.18	(0.42-11.4)	0.357	6	26	0.99	(0.17-5.64)	0.990
Poor	16,125	22	136	**0.41**	**(0.17-0.99)**	**0.046**	4	25	0.98	(0.15-6.33)	0.980	8	50	1.99	(0.39-10.1)	0.406
Satisfactory	41,578	62	136	**0.54**	**(0.26-1.12)**	**0.097**	17	37	1.52	(0.36-6.46)	0.569	20	44	1.51	(0.38-5.95)	0.559
Good	37,670	60	159	0.76	(0.40-1.44)	0.396	20	53	1.67	(0.46-6.12)	0.437	14	37	1.00	(0.29-3.40)	0.999
Excellent	10,582	21	198	1.00			4	38	1.00			6	57	1.00		

N=total number of participants; n=number of exposed; Multivariable=Variables were entered simultaneously into the logistic regression model; OR=odds ratio; CI=confidence interval.

Table III. Characteristics of conscripts according to Body Mass Index (N=124,976).

	Body Mass Index						
	<25 (n=99,933)		≥25 (n=26,958)		Multivariable BMI<25 vs. BMI≥25		
	n	(%)	n	(%)	OR	(95% CI)	p
Age							
≤19	34,982	(35.6)	8,475	(31.8)	1.00		
20	51,851	(52.7)	14,069	(52.8)	1.02	(0.98-1.05)	0.352
≥21	11,499	(11.7)	4,100	(15.4)	1.27	(1.21-1.33)	<0.001
Aerobic fitness							
Unknown	12,512	(12.7)	4,657	(18.6)	4.30	(3.81-4.86)	<0.001
Poor	7,632	(7.8)	7,266	(27.3)	8.53	(7.59-9.59)	<0.001
Satisfactory	34,843	(35.4)	9,722	(36.5)	3.88	(3.46-4.31)	<0.001
Good	33,611	(34.2)	4,068	(15.3)	1.97	(1.78-2.19)	<0.001
Excellent	9,734	(9.9)	631	(2.4)	1.00		
Muscle fitness							
Unknown	15,551	(15.8)	5,720	(21.5)	1.45	(1.30-1.62)	<0.001
Poor	8,342	(8.5)	7,414	(27.8)	2.17	(1.95-2.42)	<0.001
Satisfactory	32,282	(32.8)	8,373	(31.4)	1.08	(0.97-1.19)	0.153
Good	32,601	(33.2)	4,301	(16.1)	0.87	(0.79-0.95)	0.003
Excellent	9,556	(9.7)	836	(3.1)	1.00		
Year							
1998	17,043	(17.3)	3,977	(14.9)	1.00		
1999	21,163	(21.5)	5,225	(19.6)	1.04	(0.99-1.10)	0.110
2000	21,812	(22.2)	5,758	(21.6)	1.10	(1.05-1.16)	<0.001
2001	21,139	(21.5)	6,202	(23.3)	1.21	(1.15-1.28)	<0.001
2002	17,175	(17.5)	5,482	(20.6)	1.30	(1.23-1.37)	<0.001
Length of military service, days							
180	45,768	(46.5)	13,241	(49.7)	1.00		
240	3,181	(3.2)	909	(3.4)	1.15	(1.05-1.25)	0.003
362	49,383	(50.2)	12,494	(46.9)	1.25	(1.21-1.28)	<0.001

All differences between groups (BMI<25 vs. BMI≥25) statistically significant p<0.001 according to Pearson chi-square test. Multivariable model was performed using logistic regression adding risk factors simultaneously into the model.

Table IV. Incidence of shoulder joint dislocation, comparison between previous studies

Study (Year of publication)	Simonet et al. (1984) (20)	Krøner et al. (1989) (21)	Nordqvist & Petterson (1995) (22)	Owens et al. (2007) (28)	Owens et al. (2009) (27)	Zacchilli & Owens (2010) (23)	Liavaag et al. (2011) (24)	Taş (2013) (25)	Leroux et al. (2014) (26)	Amako et al. (2016) (29)	Kardouni et al. (2016) (30)	**Present Study**
Study population	U.S. civil.	Denmark civil.	Sweden civil.	U.S. military cadets	U.S. military	U.S. civil.	Norway civil.	Turkey civil.	Canada civil.	Japan, military cadets	U.S. military	**Finland, conscript army**
Person years	880,000	1,268,765	230,065	4134	11,680,893	1.46 billion	575,475	1,090,172	Population of Ontario 2002-2010	5,402	4,923,463	**97,949**
Shoulder joint dislocation, number	124	216	55	18	19,730	8940 (model: 349,486)	324	208	20,719	22	15,426	**132**
Confirmed 1st dislocation	66	N.A	55	12	N.A.	N.A.	151	172	20,719	N.A	N.A	**N.A.**
Incidence of 1st dislocation /100,000	8.2	12.3	23.9	290	N.A.	N.A.	26.2	5.3	23.1	N.A	N.A	**N.A.**
Peak incidence	23.4 (males 20-29 y)	N.A. (males 21-30 y)	N.A.	N.A.	235 (< 20 y)	47.8 (males 20-29 y)	204.3 (males 20-29 y)	N.A	98.3 (males <20 y)	N.A	N.A	**N.A.**
Incidence in males	11.2**	9.0**	27*	N.A.	182**	34.9**	34.8* /82.2**	8.0* /9.96**	34.3*	410	N.A	**188.9**
Incidence in females	5.0**	8.9**	22*	N.A.	90 **	13.3**	17.9* /30.9**	2.58* /2.84	11.8*	N.A.	N.A	**N.A.**
Overall incidence/100,000	**11.2**	**17**	**N.A**	**435**	**169**	**23.9**	**56.3**	**6.45**	**N.A.**	**410**	**313**	**N.A.**

*Primary acute shoulder dislocations
**Primary acute shoulder dislocations not confirmed, cumulative incidences
N.A.: A comparable numerical value not reported, the issue may have been reported in other terms or otherwise referred.