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The Swiss Army physical fitness test battery predicts risk of overuse injuries among recruits

T. WYSS [1], R. O. VON VIGIER [2], F. FREY [2], U. MÄDER [1]

[1]*Swiss Federal Institute of Sports Magglingen SFISM, Magglingen, Switzerland*
[2]*Swiss Army Medical Services, Ittigen, Switzerland*

Aim. **The aim of this study was to quantify the discriminative power of physical performance tests to recognize conscripts with enhanced risk of acute and overuse injuries in specific, physically demanding occupational specialties of the Swiss Army. The five performance tests investigated represent the Swiss Army Physical Fitness Test Battery.**

Methods. **Physical fitness performances were assessed during recruitment procedures prior to military service, and injury occurrences were assessed during 18 weeks of boot camp. Complete fitness and injury data of 459 volunteers from four military occupational specialties were collected. Discriminative power of volunteers' aerobic endurance capacity, trunk muscle fitness, muscle power of upper and lower extremities, and balance for predicting risk of acute injuries and for predicting risk of overuse injuries was calculated using receiver operating characteristic curve analysis.**

Results. **The presented fitness tests had no discriminative power for predicting the risk of acute injuries. However, the trunk muscle fitness test was discriminative in predicting overuse injuries in all four military occupational specialties, progressive endurance run in three, balance test in two, and standing long jump in one. Only the seated shot put had no significant power for predicting overuse injuries in all four study groups. However, for different occupational specialties, different fitness parameters were discriminative to predict overuse injuries.**

Conclusions. **It is possible to conclude that the fitness tests used allow detection of conscripts with enhanced overuse injury risk in physically demanding occupational specialties and therefore provide an indicator to select suitable personnel for physically demanding jobs in a military organization.**

Key words: Job description - Motor activity - Military medicine.

To prevent physical overload, health complaints, loss of time from duty, and reduced unit performance in military service, it is crucial to find an optimal balance between physical job requirements and individual physical capacity.[1-5] Suboptimal physical fitness in service members may beeven more serious than in sports athletes.[6] Particularly because a low level of physical fitness,[4, 7-9] especially of aerobic endurance,[8, 10-13] is one of the most relevant risk factors for injuries in a military population. Apart from physical fitness further factors were identified as injury risks for recruits and soldiers: physical demands in unit training, individual characteristics as previous injuries, ethnicity, gender and age as well as lifestyle factors as smoking, low level of previous physical activity and low frequency of runningbefore entering into theArmy.[8, 10] Since non-battle injury rates are the major health problem of armed forces today,[14, 15] the importance of obtaining an accurate description of the physical fitness, of lifestyle factors and of daily physical activities and demands in unit training of conscripts, recruits and soldiers cannot be overestimated.

In terms of measuring their employees' physical capabilities, all military organizations participating in the Research Technical Group of the North Atlantic Treaty Organization (NATO) test their employees' physical fitness at least once a year.[16, 17] All those fitness test batteries contain a 12-minute or a distance running test to assess aerobic endurance capacity. Most of the test batteries contain sit-

Corresponding author: T. Wyss, Federal Office of Sport FOSPO, Hauptstrasse 247, CH-2532 Magglingen, Switzerland.
E-mail: thomas.wyss@baspo.admin.ch

ups to assess abdominal muscle fitness and some contain further diverse tests to assess muscle power, like push-ups, hand grip test, standing long jump and others.[16] The Swiss Army physical fitness test battery (SPFTB) [18] consists of similar fitness parameters as listed above and additionally includes a test for balance. However, due to some reservation concerning sit-ups and the 12-minuteand distance running tests, different test disciplines than those applied by NATO members [16] are used in the SPFTB.

In the 12-minute and distance running tests, inexperienced runners have difficulties finding the optimal speed and may, therefore, be underestimated.[19] A progressive endurance run (PER) may thus be more appropriate to investigate aerobic endurance in heterogeneous groups of conscripts. The paced velocity allows individuals with low physical fitness or without experience in self-pacing to achieve their individual maximal aerobic endurance performance. PER has been shown to be of comparable reliability and validity as the 12-minute running test.[18] Sit-ups are often used to measure the muscular strength and endurance of the abdominal muscle groups. It has been reported that they actually investigate not only the abdominal muscles but the hip flexor muscles as well.[20] Further, this test was criticized by physiotherapists because it is frequently performed in an increased lumbar lordosis, placing high compression forces on the lumbar spine.[21] Some studies showed only limited reliability of dynamic or isometric sit-up tests ($r<0.50$),[22, 23] while others indicated satisfactory reliability ($r=0.72–0.84$).[24-26] Available data suggest that sit-ups yield limited to acceptable measurements of trunk muscle strength and endurance ($r=0.23-0.66$).[27] The trunk muscle strength test (TMS) used in the present study, also referred to as prone bridge, has indicated to be an interesting alternative to measure the global muscular strength and endurance of the trunk.[18, 28, 29]

In contrast to many other military organizations,[16, 30, 31] the compulsory Swiss Army uses job-specific minimum physical fitness standards to assign the conscripts to their jobs in the military service. However, today's Swiss Army job-specific minimum fitness standards contain only references to the total score achieved of the fitness test battery and are based on subjective expert appraisal. The use of more reliable job-specific minimum physical fitness standards upon recruitment that are developed based on objective data may reduce injuries in military boot camps. To identify reliable job-specific minimum fitness standards, the relationship between fitness parameters and job specific task performances, as well as injury occurrence, should be investigated. Prior studies demonstrated that some physical fitness tests are related to military task performances [3, 31-34] and to injury risk.[8, 10, 11, 35] However, since the SPFTB consists of different test disciplines than those referred to in the literature, its validity to detect recruits and soldiers with enhanced risk for injuries or with insufficient military performances has to be demonstrated first. As recommended by Jones *et al.*,[14] all injuries were classified as either an acute or overuse injury in the present study. Therefore, the discriminative power of physical performance tests was conducted for acute and overuse injuries separately.

The aim of the present study was to investigate the discriminative power of all five physical performance tests of the SPFTB to identify conscripts with enhanced risk of acute and overuse injuries during military service in four different physically demanding military occupational specialties. Hence, the validity of different fitness parameters for predicting the risk of injuries shall be discussed.

Materials and methods

Study design and participants

In the present study, volunteers' physical fitness performances assessed with the SPFTB during recruitment procedures prior to military service, and their injuries during the first 18 weeks of boot camp were investigated. The four training schools investigated were chosen by the criteria of being physically demanding based on experts' appraisal. All recruits in these boot camps (rescue technicians, armoured infantry, fusilier infantry and reconnaissance infantry school) were asked to take part in the study (Table I). The participants received comprehensive oral and written information and provided written informed consent for their participation as approved by the Cantonal Ethics Committee of Bern, Switzerland and the Swiss Army Sports and Preventions Competence Center.

TABLE I.—*Age, weight, height, body mass index, and performances in physical fitness tests of investigated subjects.*

Test	Swiss Army military training school				ANOVA (P-value)
	Rescue technicians	Armored infantry	Fusilier infantry	Reconnaissance infantry	
N	131	145	107	76	
Age (y)	20.83±1.39	20.71±0.91	20.85±1.10	20.76±1.08	0.684
Weight (kg)	74.27±12.22	72.38±7.99 [c]	76.42±12.83 [b,d]	71.67±9.46 [c]	0.007
Height (cm)	176.99±6.91	177.20±6.30	178.90±6.28	179.29±5.64	0.015
BMI	23.71±3.23 [d] (65-70%)	23.05±2.09 (60%)	23.87±3.62 [d] (70%)	22.29±2.17 [a,c] (50%)	0.001
SLJ (m)	2.29±0.22 [b,c,d] (35-40%)	2.50±0.16 [a,c] (75-80%)	2.36±0.23 [a,b,d] (50-55%)	2.50±0.17 [a,c] (75-80%)	0.000
SSP (m)	6.35±0.67 [b,c,d] (45%)	6.93±0.64 [a] (75-80%)	6.72±0.77 [a] (65-70%)	6.92±0.65 [a] (75-80%)	0.000
TMS (s)	119.80±50.34 [b,d] (55-60%)	176.48±57.35 [a,c] (80-85%)	134.25±58.43 [b,d] (65-70%)	176.83±54.99 [a,c] (80-85%)	0.000
OLS (s)	45.86±13.69 [b,d] (50-55%)	52.48±12.58 [a,c] (75-80%)	48.02±11.80 [b,d] (60-65%)	54.29±12.10 [a,c] (80-85%)	0.000
PER (s)	757.73±205.24 [b,d] (45-50%)	926.89±138.11 [a,c] (75-80%)	786.66±207.36 [b,d] (50%)	949.05±174.40 [a,c] (80-85%)	0.000

[note] Mean values and standard deviations for every assessed military training school and in parentheses respective percentile compared to standard values assessed with 12862 conscripts by Wyss *et al.*[18] are tabled for body mass index (BMI), standing long jump (SLJ), seated shot put (SSP), trunk muscle strength test (TMS), one-leg standing test (OLS), and progressive endurance run (PER).
[a,b,c,d] Significant (P<0.05) differences in Tukey *post-hoc* tests are symbolized with a (different from rescue technicians), b (different from armored infantry), c (different from fusilier infantry) and d (different from reconnaissance infantry).

Data collection

ANTHROPOMETRY AND PHYSICAL FITNESS

Anthropometry and physical performance tests were conducted by a crew of multiple examiners. Those examiners were doing this job as their profession. The crew of examiners measures more than 30000 men every year, and examiners are annually trained and regularly controlled by the Swiss Federal Institute of Sports Magglingen. Body height was measured to the nearest 0.1 cm using a stadiometer (Seca model 214, Seca GmbH, Hamburg, Germany) and body weight was measured to the nearest 0.1 kg on a calibrated digital balance (Seca model 877, Seca GmbH, Hamburg, Germany). The fitness test battery contained PER to measure aerobic endurance capacity, TMS to measure trunk muscle fitness, a standing long jump (SLJ) and a seated shot put (SSP) to measure the muscle power of the lower and upper extremities, respectively, and a one-leg standing test (OLS) to measure balance. The PER is a paced running test, conducted according to the protocol developed by Conconi *et al.*,[36] evaluated using the final running velocity. In the TMS, subjects have to hold an isometric body position (on forearms and feet with upper body and legs in a straight line) for as long as possible while lifting their feet alternately. The SLJ was performed from the gym hall floor onto a mat 7-cm height. The SSP was performed as a 2-kg-ball chest pass while sitting upright on a bench with the back in contact with a solid wall. In OLS participants had to close their eyes after 10 s and lay their head back after 20 s in position. Time was measured for the left and right leg separately and the sum of both was used as a value for balance ability. Precise descriptions of the five tests were published elsewhere.[18]

INJURIES

Injuries were registered if a subject who sustained physical damage to his body visited the medical care centre for this reason; this also served as the definition of injury. Injuries were continuously recorded on the individuals' medical records by the medical staff. The data collected included calendar date, anatomical site, diagnosis, severity and whether the symptoms were of acute or overuse onset. Acute injuries were defined as those that happened by a sudden traumatic event. Overuse injuries were defined as those that were associated with repetitive physical activities. Anatomical sites were categorized as head, shoulder, back, knee, foot, ankle, Achilles tendon and others. Categories for diagnosis were inflammation or musculoskeletal pain, sprain, contusion, strain and others. Severity was categorized either as trivial (no consequences), low (limited duty up to one week), moderate (one or more full training-days lost or limited duty for more than one week), or severe (instant discharge from service or permanent physical damage). Those categories for severity were invented especially for this study.

Statistical analysis

Statistical analysis was performed with SPSS for Windows (version 16.0, SPSS Inc., Chicago, IL) with an alpha level of 0.05 to indicate statistical significance. Descriptive statistics on fitness and acute and overuse injury data were produced for every military training school. To compare anthropometric data and the fitness performances of the recruits in the four different military training schools, a one-way analysis of variance (ANOVA) was conducted. A Tukey *post-hoc* analysis was used to evaluate pairwise differences among training schools.

The discriminative power of the physical fitness tests for predicting the risk of acute and for predicting the risk of overuse injuries was tested with a receiver operating characteristic (ROC) [37] curve analysis. If the area under the ROC curve showed a significant P-value, the cut-off point on the curve with maximal sensitivity and specificity (*i.e.*, with the best discrimination of subjects with and without acute or overuse injuries, respectively) was used as the example for injury-related minimum physical fitness standards (IMFIS, see Figure 1). In that case, the acute and overuse injury incidences, respectively, of the group of recruits who exceeded and of the group of recruits who did not exceed that specific cut-off performance, were calculated. To compare injury risk in those two study groups a chi-square test was performed. Finally, the relative risk (RR) and respective 95% confidence interval (95%-CI) for acute and overuse injuries in the group of recruits below the example IMFIS were calculated.

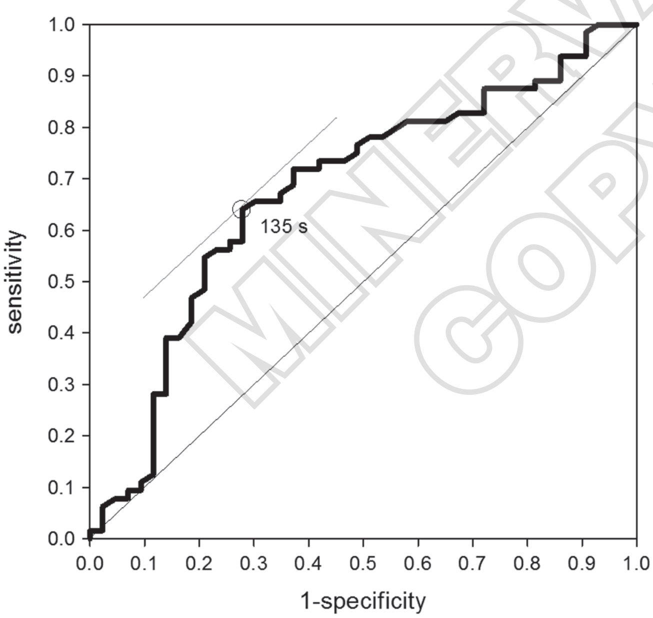

Figure 1.—Receiver operating characteristic (ROC) analysis curve for trunk muscle strength test performance of 107 fusilier infantry recruits prior to their military service and overuse injuries during service. The area under the curve was 0.677 (P=0.002).

A chart with diverse examples of IMFIS and the respective acute and overuse injury rates for subjects who achieved those IMFIS was plotted for every physical fitness test and for every military training school. The area of decreasing acute and overuse injury proportion with increasing IMFIS was detected by visual inspection of those diagrams (Figure 2). In the same figure, the proportion of Swiss Army conscripts who are expected to fulfill the corresponding IMFIS are presented. Therefore, representative standard values assessed by Wyss *et al.*[18] were applied.

Injury risk (incidence proportion) is calculated as the number of recruits with one or more injuries during 18 weeks of military service divided by the total number of assessed recruits. The injury incidence rate is expressed as the total number of injuries per month per 100 recruits.

Results

A total of 473 recruits in the four selected military training schools were asked to volunteer in the present study. Five recruits did not participate and medical records of nine recruits were not available after their service. Therefore, complete physical fitness and injury data of 459 volunteers were recorded.

The physical fitness performances, body mass index (BMI) and age of all recruits within the four military training schools are shown in Table I and compared with standard values assessed by Wyss *et al.*[18] BMI of recruits in the reconnaissance infantry school was significantly lower than in the rescue technician (P=0.004) and fusilier infantry school (P=0.001). The SLJ performances did not differ between recruits from the armoured infantry and reconnaissance infantry school only. The SSP performance of recruits in the rescue technician school was significantly lower than in the other schools. The OLS, TMS and PER performance of recruits in

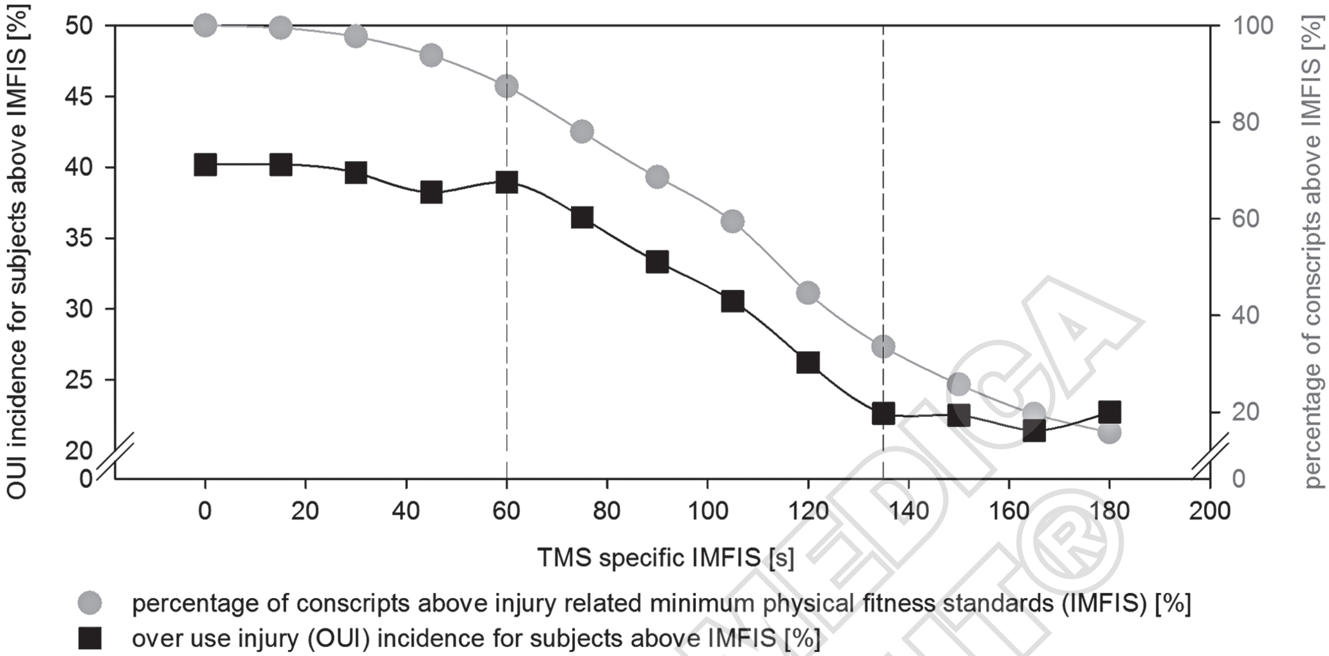

Figure 2.—Overuse injury incidence (OUI) proportion for fusilier infantry recruits with a trunk muscle strength test (TMS) performance above different injury-related minimum physical fitness standards (IMFIS). The proportion of Swiss Army conscripts fulfilling this IMFIS are based on representative standard values (N.=12862) published by Wyss *et al*. 2007.[18] Dashed lines show the area of decreasing OUI proportion with increasing IMFIS.

the armoured infantry and reconnaissance infantry school were higher than in the rescue technician and fusilier infantry school (Table I).

Physical fitness to predict risk of overuse injuries

The presented fitness tests had no discriminative power for predicting the risk of acute injuries. However, TMS had significant discriminative power for predicting the risk of overuse injuries in all four study groups. PER was discriminative for predicting overuse injuries in three, OLS in two, and SLJ in one of the study groups. SSP showed no significant power for predicting overuse injuries in all four study groups. The highest area under the ROCcurve (AUC) was found for the PER (AUC=0.706, P=0.000) and the TMS (AUC=0.677, P=0.002, Figure 1) to predict risk of overuse injuries in the fusilier infantry school. The relative risk for overuse injuries of recruits who did not achieve the cut-off values used as examples for IMFIS in this study are shown in Table II. In the four study groups (rescue technicians, armoured infantry, fusilier infantry and reconnaissance infantry), the subgroup of recruits who failed one or more of these boot camp-specific IMFIS had an enhanced overuse injury rate of about 2.6, 2.2, 2.4 and 2, respectively, compared to recruits who achieved all of the specific cut-off performances. The area of decreasing overuse injury proportions with increasing IMFIS is presented in Figure 2 and Table II.

Descriptive injury data

The total injury risk (41.2-56.6%) in the four assessed training schools did not differ significantly whereas the risk of overuse injury (Table III) in the rescue technician school (22.9%) was significantly lower than in all other boot camps (37.9-43.4%). The majority of injuries were of overuse origin (64.5%), registered in 70% of injured recruits. The anatomical site most often affected was the knee (26.9%) followed by the back and other lower extremity sites. Fifty percent of injuries were diagnosed as inflammation or musculoskeletal pain, 20.0% were classi-

TABLE II.—*Overuse injury risk in four military trainings schools and risk ratio for subjects below injury-related minimum physical fitness standards.*

Military training school	Physical fitness test	IMFIS-area of decreasing OUI proportion	Cut off example with maximal sensitivity and specificity for predicting OUI	Below cut off example		
				n_{bco}	RR (95%CI)	P
Rescue technicians	Trunk muscle strength test	80-135 s	130 s	87	2.53 (1.04-6.15)	0.025
N.=131; OUI=22.9%	One leg standing test	30-50 s	37 s	30	2.24 (1.22-4.12)	0.011
Armored infantry	Trunk muscle strength test	130-220 s	181 s	78	1.63 (1.04-2.56)	0.028
N.=145; OUI=37.9%	Progressive endurance run	700-940 s	937 s	70	2.20 (1.39-3.49)	0.000
Fusilier infantry	Trunk muscle strength test	60-135 s	135 s	52	2.19 (1.31-3.66)	0.001
N.=107; OUI=40.2%	One leg standing test	30-50 s	46 s	52	2.44 (1.44-4.14)	0.000
	Progressive endurance run	500-800 s	700 s	33	2.58 (1.67-3.99)	0.000
	Standing long jump	2.0-2.4 m	2.4 m	49	1.81 (1.12-2.92)	0.013
Reconnaissance infantry	Trunk muscle strength test	100-200 s	158 s	28	2.06 (1.25-3.40)	0.005
N.=76; OUI=43.4%	Progressive endurance run	800-1000 s	940 s	34	1.49 (0.89-2.48)	0.132

Overuse injury incidence (OUI) proportion in all four study groups, injury-related minimum physical fitness standards (IMFIS) used as examples in this study, number of subjects below the cut off values (n_{bco}), and risk ratio (RR) in the group of subjects who performed below the cut off values are tabled. Data are shown for all fitness tests which are discriminative to predict OUI ($P<0.05$, based on receiver operating characteristic analysis). N.: number of investigated subjects; P: statistical significance of differences in OUI proportion between groups of volunteers above and below cut off fitness levels assessed with Pearson's χ^2 test.

TABLE III.—*Injury incidence proportion, injury incidence rate, anatomical site, diagnosis and severity in four assessed military training schools.*

	Rescue technicians	Armored infantry	Fusilier infantry	Reconnaissance infantry	Total
Total number of subjects	131	145	107	76	459
Injury incidence rate (/month/100)	12.2	18.2	18.2	18.8	16.7
Injury incidence proportion (%)	41.2	56.6	52.3	53.9	50.8
Overuse injury incidence proportion (%)	22.9**	37.9	40.2	43.4	35.1
Anatomical site [number (% of total injuries)]					
Knee	15 (22.4)	33 (29.7)	18 (22.0)	20 (33.3)	86 (26.9)
Back	5 (7.5)	10 (9.0)	13 (15.9)	4 (6.7)	32 (10.0)
Achilles tendon	6 (9.0)	10 (9.0)	9 (11.0)	7 (11.7)	32 (10.0)
Foot	7 (10.4)	12 (10.8)	8 (9.8)	4 (6.7)	31 (9.7)
Ankle	3 (4.5)	12 (10.8)	9 (11.0)	6 (10.0)	30 (9.4)
Shoulder	2 (3.0)	2 (1.8)	6 (7.3)	1 (1.7)	11 (3.4)
Head	2 (3.0)	6 (5.4)	1 (1.2)	0 (0.0)	9 (2.8)
Other lower extremity sites	7 (10.4)	5 (4.5)	2 (2.4)	6 (10.0)	20 (6.3)
Others	20 (29.9)	21 (18.9)	16 (19.5)	12 (20.0)	69 (21.6)
Diagnosis [number (% of total injuries)]					
Inflammation or pain	23 (34.4)	52 (46.8)	49 (59.8)	36 (60.0)	160 (50.0)
Sprain	15 (22.4)	23 (20.7)	18 (22.0)	8 (13.3)	64 (20.0)
Strain	3 (4.5)	4 (3.6)	2 (2.4)	2 (3.3)	11 (3.4)
Contusion	4 (6.0)	2 (1.8)	2 (2.4)	2 (3.3)	10 (3.1)
Others	22 (32.8)	30 (27.0)	11 (13.4)	12 (20.0)	75 (23.4)
Severity [number (% of total injuries)]					
Trivial	32 (47.8)	21 (18.9)	14 (17.1)	16 (26.7)	83 (25.9)
Low	30 (44.8)	58 (52.2)	51 (62.2)	26 (43.3)	165 (51.6)
Moderate	5 (7.5)	27 (24.3)	16 (19.5)	16 (26.7)	64 (19.1)
Severe	0 (0.0)	5 (4.5)	1 (1.2)	2 (3.3)	8 (2.5)

** significantly lower ($P=0.008$) than in the three other military training schools.

fied as sprains, 3.4% as strains and 3.1% as contusions. Many injuries (77.5%) were trivial or of low severity, causing limited duty for up to one week. Only 2.5% of all injuries were severe, causing immediate discharge from service or permanent physical damage (Table III).

Discussion

Physical fitness to predict risk of overuse injuries

It may be assumed that the physical demands on individuals in the same boot camp are similar. Therefore, less fit trainees fatigue faster because they perform at a higher percentage of their maximal physical capacity. Consequently, injuries and discharges may be more likely in less fit trainees. Previous studies found the strongest association between a fitness parameter and injury incidence in military service for aerobic endurance.[7, 12, 38] Consistent with the previous studies, the aerobic endurance test used in the present study showed a strong discriminative power to predict overuse injury risk.

Less consistent and less significant associations between muscle fitness measures such as push-ups or sit-ups and risk of injury were found in previous studies.[8, 11, 12, 39, 40] Divergent from those studies, our data suggests that the TMS may strongly predict injury risk during military service. TMS is an isometric test of trunk muscle fitness, utilizing all trunk muscles including supporting shoulder, hip and leg muscles at the same time. As Bourban *et al.*[28] quantified, this test detects the weakest link in the chain of individuals' trunk muscles. Conducting TMS in larger groups is as feasible as sit-ups and curl-ups. Its test-retest reliability expressed as a Pearson correlation coefficient was found to be r=0.77 to 0.87.[18, 28, 29] These values are in the upper range of results reported for sit-ups and curl-ups.[22-26] Based on those strengths, we conclude that the TMS may outclass sit-ups and curl-ups as a test to assess the physical capacities of conscripts in military occupational selection procedures. Further research should be conducted to investigate TMS's value in injury protection in other physical demanding occupations and in sports athletes.

A negative association between balance ability assessed with one leg standing tests and injury risk during physical training or sport has been shown before in college students and athletes.[41, 42] However, to our knowledge, the present study is the first to assess a balance test's discriminative power to predict injury incidencein a military setting. The present results indicate that the OLS may be an even stronger predictor of overuse injuries than tests of muscle power in upper and lower extremities (SSP and SLJ).

Injury-related minimum physical fitness standards

The cut-off values used in the present study as examples for IMFIS represent the values with the highest accuracy in predicting overuse injuries. However, these values are not necessarily the ideal IMFIS. They were used as examples to quantify the potential effect on injury-prevention by the use of minimum standards at the recruitment of military organizations. These examples demonstrate that new, more reliable IMFIS applied at the recruitment of the Swiss Army do have the potential to reduce the number of overuse injuries during boot camp of physically demanding occupational specialties. Still, ideal IMFIS first have to be identified. For maximum injury protection, cut-off values must be high, increasingly precluding assignment of recruits (Figure 2). On the other hand, to find enough recruits for every occupational specialty, cut-off values must be low, reducing the effect on injury protection. Therefore, ideal cut-off values shall be in the range of the IMFISarea with decreasing overuse injury proportion presented in Figure 2 and Table II. Smaller cut-off values do not have any effect on injury protection and cut off-values above that range do unnecessarily preclude assignment of some conscripts.

For military or sports institutions with tools of continuous and automated medical and personnel data bases as recommended by the USA Armed Forces Epidemiological Board,[14] it would be only a small effort to examine injury-related validity of used fitness parameters and effect of respective cut-off values for injury prevention by the use of the presented method.

Description of injuries in Swiss Army basic training

For comparisons of injury incidences among studies, differences in injury definitions and methods of data collection must be considered. Only studies with similar recruits and methodology to assess and define injuries are considered here.

The injury incidence rate in three out of four training schools in the present study (18.2-18.8 injuries per month per 100 male recruits) is by trend higher than the 10-15 injuries per month per 100 male recruits found in meta analyses of previous review studies.[30, 43] There are actually a few other studies among USA and Norwegian trainees that also found injury rates of over 15 injuries per month per 100 male recruits.[35, 44, 45] The lower extremities are most often affected (62% of injuries). This finding is consistent with comparative studies referring to 58-78% of injuries to lower extremities.[11, 35, 46] The knee is the anatomical site most often affected in Swiss Army military service (27%) and is in the upper range of data in comparative studies (10-28%).[8, 11, 45, 46] Injuries to the back are more common in Swiss Army recruits (10%) than in the USA Army trainees (up to 8%).[8, 11, 45] On the other hand, the foot (10%) and ankle (9%) are less often affected than in comparative studies (11-26%, and 10-13%, respectively).[8, 11, 45, 46] Health complaints concerning the Achilles tendon are more common in Swiss recruits compared to USA recruits (10% *versus* up to 3%).[11, 45]

The outlined differences between injury data in the present study compared to the literature may be the result of diverse causes. Differences in the kind of armed forces (the Swiss Army is compulsory), physical training programs, material (as jackboots), physical capabilities of the trainees and inhibition thresholds to visit the medical care centre may cause the diversity.

Limitations of the study

The numbers of recruits in the four study groups differ. While in the armoured infantry school data of 145 volunteers were collected, in the reconnaissance infantry school only 76 volunteers were investigated. However, every volunteer of the formation cycle in the four designated military training schools was assessed.

Low physical fitness is only one of many risk factors for injuries during daily military routines.[12]Within the bounds of the presented study, investigation of further risk factors like conscripts' individual characteristics (prior injuries for example) [8] and lifestyle factors (smoking habits, for example) [8] were not possible. In a follow-up intervention study it would be necessary to assess further risk factors. Nevertheless, the aim of the present study was to discuss validity of different fitness parameters for predictingthe risk of injuries. For that purpose the presented univariate analyses shall be sufficient.

Conclusions

The present study shows that the fitness tests used during the Swiss Army recruitment, especially the TMS and the PER, have a strong discriminative power for predicting overuse injuries during military service. The results indicate that the test disciplines of the SPFTB are at least as powerful to detect recruits with enhanced overuse injury risk as fitness tests referred to in prior studies. TMS may even outclass the popular sit-up test to assess trunk muscle fitness in an occupational setting. Further, OLS was shown to be a successful extension of the test battery for injury related selection in a military setting. However, for unlike occupational specialties, different fitness parameters were identified to be discriminative for predicting overuse injuries. We finally conclude that the fitness test battery used during the recruitment of the Swiss Army is appropriate to detect conscripts with enhanced risk of overuse injuries and therefore provides a valid indicator to select suitable personnel for physically demanding military occupational specialties.

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