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Adapted Marching Distances and Physical Training Decrease Recruits' Injuries and Attrition

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ABSTRACT There is evidence that progressive loading of physical demands at the beginning of basic military service and specific physical training can reduce injury incidences. Therefore, aim of this study was to measure the effects of a progressive increase in marching distances and an adapted physical training program on injury incidence and attrition rate in a Swiss Army infantry training school. One company reduced the distances covered on foot during the first 4 weeks of basic military training. A second company performed an adapted physical training program for 10 weeks. A third company participated in both interventions combined, and a fourth company served as a control group without any intervention. The injury incidences and attrition rates of 651 male recruits were registered during 21 weeks of military service. Several predictor variables for injury and attrition, such as physical fitness, previous injuries, level of previous physical activity, smoking, motivation, and socioeconomic factors, were assessed as well. The data were analyzed using binary logistic backward regressions. Each intervention separately had a favorable effect on injury prevention. However, combining the 2 interventions resulted in the greatest reduction in injury incidence rate (−33%). Furthermore, the adapted physical training successfully reduced the military service attrition rates (−53%).

INTRODUCTION

Injuries, specifically overuse injuries, are a major health problem in most armed forces all over the world.[1–5] Several factors have already been associated with an injury risk or a higher rate of attrition.[6] The factors that have been identified as responsible for higher injury rates are age, female gender, Caucasian race, married marital status, lower educational level, high or low body mass index (BMI), low level of previous or current physical activity (PA), low aerobic fitness or muscle endurance, previous injuries, smoking, high weekly running mileage, and high amount of weekly exercise.[7–9] The factors that have been identified as responsible for higher attrition rates are age, lower educational level, low income, poor health status, low and high BMI, low PA, low physical fitness, previous and acute injuries, smoking, and not belonging to a sports club or gym.[10–12]

Many intervention studies have shown that a reduced weekly running mileage decreased the physical load on recruits, but did not decrease their physical fitness. The injury rates decreased significantly because of these interventions.[3,13,14] Additionally, endurance training performed in ability groups has a high potential for optimizing individual training stimulus and reduces injury risk as well.[4,15] Interval trainings, instead of conventional long endurance runs, can have a positive effect on injury prevention during basic military training (BMT).[16,17] The same can be said for a progressively increased running distance and training regimen in general.[15,18,19] Furthermore, several studies have shown that neuromuscular balance training is associated with a decreased risk of ankle injuries.[20–23]

Hence, there is evidence that a progressive loading of daily military demands at the beginning of BMT and specific physical training (PT) can both be used to reduce injury incidences in military training schools. The purpose of this study was to examine whether an intervention with a reduction of the marched distances during the first 4 weeks of BMT, an adapted PT intervention, or a combination of both interventions is more effective in decreasing injury and attrition rates from military service.

MATERIALS AND METHODS

Participants and Study Design

In 2 consecutive BMT cycles, 693 young men started their mandatory military service of 21 weeks in a Swiss Armed Forces garrison. After receiving oral and written information about study design and purpose, the recruits were asked to sign a written consent form approved by the local ethics committee.

This intervention study aimed for 2 goals. First, the study intended to reduce the physical demands at the beginning of BMT. Therefore, the daily distance covered on foot (DOF) was reduced during the first 4 weeks of BMT. Second, the study intended to ensure that the recruits participated in 180 minutes of adapted PT sessions per week during the first 10 weeks of BMT. The adapted DOF intervention group consisted of one company that reduced the daily DOF at the beginning of BMT. The adapted PT intervention group consisted of a second company that participated in the adapted PT only. The PT&DOF intervention group was a third company that implemented both interventions combined.

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The fourth company did not participate in any intervention and served as the control group. All study groups were from the same BMT school. Therefore, the military training and tasks were the same for the recruits from all study groups. Fidelity and accuracy of implementation of the interventions was assessed by a weekly questionnaire. The adapted DOF intervention group increased the weekly mileage of the distances walked on foot progressively over the first weeks of BMT. Therefore, recruits were transported by vehicles to exercise grounds in the first 4 weeks of BMT. The main activities in the adapted PT were high-intensity interval endurance runs, functional strength circuit training, balance training with unstable devices such as slacklines (Slacktivity.ch GmbH, Zurich, Switzerland) and wobble boards (Syboba GmbH, Jona SG, Switzerland; Trend Sport Trading GmbH, Grosshöflein, Austria), different team sports, and a warm-up phase at the beginning, active relaxation, and regeneration after each training session. The recruits trained each PT activity once a week for 30 to 60 minutes. The intensity of the exercises during the adapted PT sessions was progressively increased. To ensure the high quality of the adapted PT, each session was instructed and supervised by trained professionals. The adapted DOF intervention and the control group performed the standard PT program according to Swiss Armed Forces regulation. This PT consisted of 2 training sessions with a total duration of 180 minutes per week. Normally, a group of 20 to 50 recruits is supervised by 1 army PT instructor. Each training session includes 15 minutes of cardiovascular warm-up exercises and dynamic stretching at the beginning and 15 minutes of cool down exercises and static stretching at the end of the session. The main part changed with each training session: strength and aerobic fitness training (7 sessions in 11 weeks), team sports (5 sessions in 11 weeks), obstacle courses (2 sessions in 11 weeks), physical fitness test (3 tests in 11 weeks), and orienteering (1 session in 11 weeks). Training content is normally chosen by the supervisor or depending on available infrastructure and daily weather.

Fitness Testing

During the first week of BMT, the recruits performed a physical fitness test. The fitness test battery consisted of 5 exercises and 2 anthropometric measurements: standing long jump, seated shot put, one-leg stand (OLS), trunk muscle strength (TMS), and progressive endurance run (PER), plus body height and weight. These tests were used to measure explosive strength (muscular power) of lower and upper extremities, the balance abilities of both legs (duration on both legs summed and asymmetry between legs). Further, the trunk muscular fitness during the prone bridge and the aerobic fitness when performing the Conconi[24] running protocol (assessed as final running speed). A precise description of the different performance tests and standard values was published by Wyss et al.[25] All the tests together resulted in a total fitness score of 0 to 125 points. The anthropometrical data were collected with a portable stadiometer (Seca model 213, Seca GmbH, Hamburg, Germany) to the nearest 0.1 cm and a calibrated scale (Seca model 861) to the nearest 0.05 kg. BMI was computed as weight/height^2 (kg/m^2).

Risk Factors

To assess the potential predictor variables for the injury and attrition rates, a self-reported questionnaire was used in the first week of BMT. The recruits had to report their previous PA, smoking behavior, age, and level of school education. Previous injuries during the past year had to be reported when a physician's visit was necessary because of an injury or accident. Furthermore, the German short version of the Achievement Motivation Inventory questionnaire (30 items[26]) was used to assess the recruits' work-related achievement motivation.

Injury Incidence Risk and Attrition Rate

During the 21 weeks of BMT, the injury and attrition data were collected continuously. Injuries were defined as and, thus, recorded when a recruit sustained physical damage and visited a physician at the medical care center. Visits because of illness were not assessed. The medical personnel were the same during the study period and were not aware of the patients' group affiliation. Calendar date, anatomical site, severity, and a description of the kind of injury and whether it was of an acute or overuse onset were noted in the individual's medical record. Acute injuries were caused by a sudden single traumatic event, whereas overuse injuries originated from prolonged stress through repetitive physical activities. For severity, each injury was classified as trivial (no consequences), light (limited duty up to 7 days), moderate (1 or more full training days lost or limited duty for more than 7 days), or severe (instant discharge from military service or permanent physical damage).[27] The injury incidence rates (injuries per 100 recruits per month) were calculated as ([number of total injuries/n] $\times$ 100)/(21 weeks/4 weeks). The injury incidence proportion (%) was calculated as (number of recruits with ≥1 injury/n) $\times$ 100. Military service attrition was registered when a physician identified a recruit as physically or mentally unable to continue military training. This information included the date and reason for the military discharge, medical or psychological. The attrition rate (%) was calculated as (number of attrition/n) $\times$ 100.

Physical Demands and DOF

To assess the daily military activities and physical demands, 2 groups of 25 recruits from each company wore body-wearable sensors alternately every other week during weeks 2 to 9. The recruits received 2 uniaxial accelerometers (PARTwear, HuCE microLab, Biel, Switzerland; GT1M, ActiGraph, Pensacola, Florida) and a heart rate monitor (Dual Comfort Belt, Suunto, Vantaa, Finland). One sensor was worn in a belt pouch on the right hip just above the iliac crest and the other sensor was fixed on the right-side strap of the individual's backpack. The recruits were instructed to wear these sensors from the moment they woke up until they went to bed. The data were analyzed with a self-programmed application using Matlab (Matlab 2011, MathWorks, Natick, Massachusetts). The algorithms initially computed values for physical activity energy expenditure (PAEE) and DOF per minute. To further analyze the data, the daily medians of total PAEE and DOF of all participants wearing sensors were computed for each company.[19,28] The daily results were then used to calculate weekly means and standard deviations.

Operational Definitions

Smoking behavior was stratified into: 1 = smoking of 1 or more daily cigarettes and 0 = not smoking. Previous injuries were stratified into 1 = sustained a previous injury and 0 = no previous injuries. School education level was stratified into 3 groups, with 1 = lower secondary school, 2 = upper secondary school, and 3 = baccalaureate school. Concerning motivation, the final score of the Achievement Motivation Inventory questionnaire was used for the analysis. PA level was calculated as minutes of moderate and vigorous PA per week. Continuous variables were used for the remaining parameters (age, BMI, and fitness tests).

Statistical Analysis

IBM SPSS Statistics 20 for Windows (IBM Corporation, Armonk, New York) was used for the statistical analysis.

The level of significance was set at $\alpha = 0.05$. The statistical methods applied were a one-way analysis of variance and a χ^2 test to identify group differences. A Bonferroni post hoc test was applied where necessary for multiple group comparisons. Binary logistic backward regressions were applied to identify possible risk factors that influence injuries and attrition from BMT. Previous PA level, age, previous injuries, smoking behavior, BMI, fitness test performances, educational level, and motivation were set as individual predictor variables. Furthermore, group affiliation to the adapted DOF or the adapted PT intervention was included as a group-specific predictor variable. To avoid strong colinearity, possible correlations between the independent variables were investigated before the inclusion of the variables in the analysis. A receiver operating characteristic (ROC) curve analysis was performed for standing long jump, seated shot put, OLS-duration, OLS-asymmetry, TMS, and PER to identify the relevant variables to predict injury. Only the variables with a significant area under the ROC curve (AUC) were used as individual predictor variables in the binary logistic backward regression. Odds ratios (ORs) were calculated for variables remaining in the model. The ORs were displayed with 95% confidence intervals (CI).

RESULTS

Participants and Ambulatory Monitoring

Of the 693 male recruits asked to volunteer for this study, 651 recruits participated. Of these, the complete injury data of 619 volunteers (95.09%) were available. The age, height, weight, BMI, and total fitness score are presented in Table I as mean ± standard deviation. There was no significant difference between the anthropometric data of the 4 study groups.

Of the 200 volunteers asked to wear sensors, 22 recruits (11.00%) failed to wear the sensors because of early attrition from their service in week 1 of BMT. The remaining volunteers (n = 178) did not differ significantly from the total group of recruits (n = 619) in age, height, or weight. Since the majority of recruits in Swiss BMT do not serve on weekends, only data from Mondays through Thursdays were included in the analysis because the return rate of the sensor data was insufficient on Fridays. Finally, 50.60% of the sensor data were used for analysis, 32.90% of the data were lost because of technical or mechanical problems with the sensors, and 16.50% were excluded from analysis because the devices were not worn properly.

Injury Incidence and Attrition Rate

The observed injury incidence rates of the 4 study groups are shown in Table II. The number of total and acute injury incidence rates were significantly different ($F = 3.113$, $p = 0.026$ and $F = 3.204$, $p = 0.023$, respectively) between the groups. The control group recruits had a significantly greater total number of injuries than those of the combined PT&DOF intervention group ($p = 0.036$). When looking at acute injuries only, a significantly smaller acute injury incidence rate ($p = 0.021$) and a smaller injury incidence proportion ($\chi^2[3] = 7.771$, $p = 0.005$) were observed for the participants of the PT&DOF compared to those of the adapted DOF intervention

TABLE I. Characteristics of Participants of Each Study Group

	Control	Adapted DOF Intervention	Adapted PT Intervention	PT&DOF Intervention
N	112	165	163	179
Age (Year)	20.54 ± 1.34	20.78 ± 1.27	20.52 ± 1.31	20.59 ± 1.24
Height (cm)	177.76 ± 6.51	177.36 ± 6.11	177.66 ± 6.37	177.25 ± 6.07
Weight (kg)	71.86 ± 10.38	74.51 ± 12.26	73.61 ± 10.22	75.62 ± 10.98
BMI (kg/m^2)	22.71 ± 2.84	23.63 ± 3.28	23.32 ± 3.06	24.06 ± 3.20
Total Fitness Score (AU)	70.76 ± 11.05	70.42 ± 11.97	69.83 ± 12.75	72.39 ± 13.51

AU, Arbitrary unit.

TABLE II. Injury Incidence, Injury Proportion, and Attrition Rates of the 4 Study Groups

	Control	Adapted DOF Intervention	Adapted PT Intervention	PT&DOF Intervention
N	112	165	163	179
Injury Incidence Rate				
Injuries (/100 Recruits/Month)	21.26[a]	19.86	17.35	14.26[b]
Acute Injuries (/100 Recruits/Month)	10.88	11.89[a]	9.79	7.01[c]
Overuse Injuries (/100 Recruits/Month)	10.38	7.97	7.56	7.25
Injury Incidence Proportion				
Injuries (%)	58.77	59.88	56.83	48.11
Acute Injuries (%)	40.18	43.64[a]	37.43	28.83[c]
Overuse Injuries (%)	40.18	31.52	31.28	27.61
Attrition Rate (%)	13.39	13.33	5.59	8.59

[a]Significantly different from PT&DOF intervention. [b]Significantly different from control. [c]Significantly different from adapted DOF intervention.

group. A similarly high attrition rate for the recruits of the control and adapted DOF intervention groups was observed, whereas those of the adapted PT and PT&DOF intervention groups showed a 53% smaller attrition rate on average (Table II). Overall, 58.33% of attritions were because of physical problems and 41.66% because of psychological reasons.

In total, 622 injuries were recorded. The anatomical sites that were injured most often were knee and back with 31.51% and 15.11% of the injuries, respectively, followed by foot (9.97%), ankle (7.07%), and hip injuries (4.98%). The lower extremities were concerned in 60.06% of the cases. Most of the injuries were trivial or of light severity (75.92%). Further, 19.06% of injuries were moderate and 5.02% severe. In the control group, 5.83, 9.33, 4.50, and 1.33 cases/100 recruits/month, and 4.29, 4.95, 4.01, and 0.75 cases/100 recruits/month in the PT&DOF intervention were classified as trivial, light, moderate, and severe injuries, respectively.

Physical Demands and DOF

The weekly PAEE, DOF, and PT data of the 4 study groups are shown in Table III. A difference in PAEE values was registered between the control and adapted DOF intervention groups only ($p = 0.047$), with the control group recruits having smaller PAEE. The volunteers in the adapted DOF intervention group had the most progressive development of DOF, followed by those in the PT&DOF intervention group. Furthermore, the participants in the adapted PT and PT&DOF intervention groups had significantly more instructors supervising the PT lessons than those in the control and the adapted DOF intervention groups.

Risk Factors for Injuries and Attrition

ROC analysis identified TMS and PER as the significant variables for injury prediction. Similar AUC were observed for PER (AUC = 0.599, $p = 0.001$) and TMS (AUC = 0.576, $p = 0.001$). As further potential predictors of injury risk and attrition rate, the independent variables age, previous injury, smoking, previous PA level, BMI, educational level, motivation, and group affiliation were investigated. Binary logistic backward regression revealed the following variables as significant risk factors for injuries in a military setting (Table IV): higher age, smoking, previous injury, low BMI, low initial PER performance, and high overall performance motivation.

When considering acute injuries only, affiliation to any of the intervention groups, higher age, previous injuries, smoking, and a lower educational level were identified as having an influence on injury incidence rates (Table V). However, the fitness performances at the beginning of BMT did not have a significant effect on acute injury incidence rate. All intervention groups had a decreased acute injury risk with the greatest reduction for the PT&DOF intervention (OR = 0.513, $p = 0.025$), followed by the adapted PT intervention (OR = 0.657, $p = 0.149$) and the adapted DOF intervention (OR = 0.881, $p = 0.661$).

For overuse injuries, the variables smoking (OR = 1.393, $p = 0.08$), low initial PER score (OR = 0.999, $p = 0.029$), and

TABLE III. Progressive Loading of Physical Demands and PT

	Control	Adapted DOF Intervention	Adapted PT Intervention	PT&DOF Intervention
N	38	40	46	46
PAEE (MJ/week)	10.63 ± 0.81[a]	12.89 ± 2.12[b]	12.35 ± 1.84	12.39 ± 1.02
DOF (km/week)	15.06 ± 2.22	14.63 ± 3.87	15.73 ± 2.03	18.24 ± 2.06
ΔDOF (km/week)	−2.94	3.45	−1.44	2.11
PT (min/week)	136.82 ± 50.60	143.60 ± 99.27	139.59 ± 36.26	150.88 ± 15.44
Instructors (Per 30 Recruits)	0.67 ± 0.16[cd]	0.65 ± 0.14[cd]	1.78 ± 0.35[ab]	1.43 ± 0.63[ab]

Δ, difference of DOF between week 9 and 2 of BMT. [a]Significantly different from adapted DOF intervention. [b]Significantly different from control. [c]Significantly different from adapted PT intervention. [d]Significantly different from PT&DOF intervention.

TABLE IV. Binary Logistic Backward Regression Analysis: Injury Risk Factors

Predictor Variable	Unit (Range)	B	SE	p	OR (95% CI)
Age	Years (18–26)	0.138	0.075	0.065	1.148 (0.992–1.329)
Previous Injuries	1 = Yes, 0 = No	0.347	0.189	0.066	1.415 (0.977–2.050)
Smoking	1 = Yes, 0 = No	0.650	0.189	0.001	1.916 (1.322–2.777)
BMI	kg/m^2 (17.03–37.31)	−0.053	0.031	0.095	0.949 (0.892–1.009)
PER	Seconds (125–1255)	−0.001	4.640E-04	0.001	0.999 (0.998–0.999)
Motivation	Score (39–209)	0.009	0.003	0.008	1.009 (1.002–1.015)
Constant		−1.849	1.751	0.291	0.157

B, Beta value; SE, Standard error; *p*, Statistical significance.

TABLE V. Binary Logistic Backward Regression Analysis: Acute Injury Risk Factors

Predictor Variable	Unit (Range)	B	SE	p	OR (95% CI)
Group Affiliation	Control = Reference			0.077	
	Adapted DOF Intervention	−0.127	0.288	0.661	0.881 (0.501–1.551)
	Adapted PT Intervention	−0.419	0.290	0.149	0.657 (0.372–1.162)
	PT&DOF Intervention	−0.667	0.299	0.025	0.513 (0.286–0.921)
Age	Years (18–26)	0.126	0.075	0.092	1.134 (0.980–1.312)
Previous Injuries	1 = Yes, 0 = No	0.376	0.191	0.049	1.456 (1.001–2.118)
Smoking	1 = Yes, 0 = No	0.650	0.190	0.001	1.915 (1.321–2.778)
Educational Level	Level of Degree (1–3)	−0.263	0.125	0.036	0.769 (0.601–0.983)
Constant		−2.722	1.642	0.097	0.066

B, Beta value; SE, Standard error; *p*, Statistical significance.

high motivation (OR = 1.007, $p = 0.024$) were observed to increase overuse injury risk.

The potential risk factors for attrition from BMT were analyzed with binary logistic backward regression, using the same predictor variables as for injuries. Group affiliation to any intervention group, smoking and BMI, remained in the model. Attrition rate was decreased for the adapted PT intervention (OR = 0.276, $p = 0.008$), PT&DOF intervention (OR = 0.439, $p = 0.076$), and adapted DOF intervention (OR = 0.588, $p = 0.224$). However, a higher attrition rate was observed in recruits who smoked regularly (OR = 2.357, $p = 0.007$) and those who had a higher BMI (OR = 1.155, $p = 0.001$).

DISCUSSION

Effects of the Interventions on Injury Incidence Rates

The injury incidence rates (12–19 per 100 recruits per month) in the Swiss Armed Forces have been reported to be higher than comparable numbers (10–15 per 100 recruits per month) from other nations' military organizations.[18,27] In this study, injury incidence rates from 14 to 21 per 100 recruits per month were observed in Swiss infantry recruits. The control group had the highest and the combined PT&DOF intervention group had the lowest injury incidence rate of all 4 study groups. The results showed that both interventions, adapted DOF and adapted PT, do have a positive effect on injury prevention, as hypothesized. The adapted DOF intervention has a stronger effect in the prevention of overuse injuries, whereas the adapted PT intervention has more influence in the reduction of acute injuries. Therefore, the observed injury prevention effect is considerably more pronounced when both interventions are combined.

The adapted DOF intervention resulted in more time for the recruits to accustom themselves to the new physical demands at the beginning of BMT. Consistent with previous intervention studies,[3,14] both adapted DOF intervention groups recorded fewer overuse injuries than the control group (Table II).

All 4 study groups spent a similar amount of time (137–151 minutes per week; Table III) on PT. However, the number of acute injuries was reduced in those study groups with the adapted PT intervention. The adapted PT intervention groups trained weekly balance, TMS, aerobic endurance, and team sports. Balance training has been previously shown to be useful in acute injury prevention in high school and college athletes.[20,22,23] The balance training executed in this study contained different exercises on unstable boards and slacklines. It might be because of this balance training that the recruits were able to increase their muscle control during unexpected perturbations and therefore reduce the number of acute injuries. In the common Swiss Armed Forces PT,[29] as executed in the control group, the recruits were not specifically trained on balance abilities. The interval endurance and TMS training program might explain the fact that the adapted

PT intervention seems to have a small positive effect in the prevention of overuse injuries as well. Instead of the common long-distance endurance runs, the recruits in the adapted PT intervention groups performed high-intensity interval runs. Other studies have shown that reducing the mileage in endurance runs results in a significant reduction of injury rates (up to 27% reduction in injury rates for the same measurement period).[9,19,20,30]

In this study, all intervention groups were able to reduce the injury rates compared to the control group. Especially, the injuries of light severity leading to limited duty up to 7 days. These injuries do not pose a great problem for the affected individuals, however, they are a burden for the company because these individuals remain with their training group despite their temporarily limited capacities.

Risk Factors

Several potential risk factors for high injury and attrition rates were identified. In agreement with previous studies,[3,6,8,9,31] risk factors, such as low previous PA level, age, previous injuries, smoking, low initial fitness level, high and low BMI, and a high motivation to perform well, were identified as having an effect on the outcome variables. The reason for the strong effect of smoking and motivation on injury rate is less evident than the largely discussed effects of the variables of fitness, PA level, previous injuries, and BMI. Certainly, it is well known that smoking is a risk factor not only for total injuries but also for acute and overuse injuries and attrition from military service.[7,32] This can be partly explained by the fact that smoking impairs wound and bone healing, reduces tissue strength,[33–36] and negatively affects immune functions.[37,38] A few studies have shown that nicotine binding at specific cell receptors causes additional cell depolarization, resulting in increased postural sway,[39,40] which translates into decreased balance abilities, therefore, compromising trunk strength and increasing fall and injury risk. In addition, some studies have reported that smokers are more likely to take higher risks.[41,42] It was further observed that the higher the recruits' motivation, the higher the injury outcome. However, the higher injury rate of the highly motivated recruits cannot be explained by greater PAEE or DOF compared to their less motivated peers (Roos et al, ICAMPAM 2013 conference abstract). Furthermore, the risk factor of low fitness can be reduced by only selecting appropriately fit recruits for different military branches of service or by specific PT.[43]

Attrition Rates

The volunteers in the control group had the highest attrition rate, with 13.39% of these recruits being released from military service early because of physical or psychological problems. The attrition rates of the participants in the intervention groups differed between 5.59% and 13.33% (Table II). These numbers are comparable to those reported by other military organizations (8.00%–10.40%).[10,44] Binary logistic backwards regression revealed smoking and a high BMI as positive risk predictors and affiliation to any of the intervention groups as a negative risk predictor. These results show that the interventions implemented in this study reduced the attrition rates in a relevant manner. This might be as a result of injury prevention or meaningful and motivational experiences during the adapted DOF and PT interventions. The recruits of the adapted PT interventions could have been more motivated to finish their military service because of the personal benefits that arose from the noticeably improved individual fitness levels because of the more qualified supervision and the comprehensive content. The recruits of the adapted DOF intervention might have benefited from the reduced marching distances at the beginning of the BMT and the progressive increase of the weekly marched mileages. The effect of smoking on health, balance, and risk taking has been discussed above, and these effects likely lead to an increased attrition rate as well. The effect of having a BMI above the normal range on attrition rate has been discussed in diverse ways in the literature. Some studies have reported no or small effects of a low or high BMI on attrition rate,[12,45] whereas others found increased attrition rates.[46]

Strengths and Limitations

It was an advantage that the 4 study groups were based at the same garrison. Therefore, the content of the military training was the same for all study groups. Furthermore, the previously known individual risk factors for injuries were assessed at the beginning of BMT and included as independent variables in the analysis. One limitation was the impossibility of providing all recruits with a sensor set. However, the recruits who did wear the sensors were representative of their study group. A data loss of the extent observed in this study was not unexpected since an attrition rate of 10% of recruits is common in the Swiss Army. Furthermore, data loss occurs due to training days lost because of illness or injuries and because of mechanical defects of the sensors, which are not uncommon when the devices are applied in a physical demanding setting like BMT. However, since all the recruits in each group underwent the same military training, this data loss does not impair generalizability. A further limitation was the lack of random assignment of volunteers to the 4 study groups. Though, a random assignment of participants to intervention or control groups was impossible because of organizational limitations in the Swiss Armed Forces.

CONCLUSION

The adapted PT intervention program is successful with regard to acute injury and attrition prevention. However, to further distinguish the effects of every single PT activity, more research is required. A progressive increase in the daily physical demands, as in the adapted DOF intervention, is meaningful for overuse injury prevention. The 2 interventions investigated in this study are complementary. Therefore, the implementation of both interventions in the BMT programs of all Swiss Armed Forces is recommended.

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