American Journal of
Preventive Medicine

REVIEW ARTICLE

Nonexercise Interventions for Prevention of Musculoskeletal Injuries in Armed Forces: A Systematic Review and Meta-Analysis

Ilgin G. Arslan, MSc,[1,2] Iris Dijksma, MSc,[1,3] Faridi S. van Etten-Jamaludin, BA,[4] Cees Lucas, PhD,[1] Martijn M. Stuiver, PhD[1]

Context: This study evaluates the effect of nonexercise interventions on the reduction of risk for musculoskeletal injuries in armed forces.

Evidence acquisition: A database search was conducted in PubMed/MEDLINE, Embase, Cochrane Library, CINAHL, SPORTdiscus, Greylit, Open Grey, the WHO trial registry, and the reference lists of included articles up to July 2019. RCTs and cluster RCTs evaluating nonexercise interventions for the prevention of musculoskeletal injuries in armed forces compared with any other intervention(s) or no intervention were eligible for inclusion. Data extraction and risk of bias assessment were done by 2 authors independently, followed by meta-analysis and Grading of Recommendations Assessment, Development, and Evaluation assessment, if appropriate.

Evidence synthesis: This study included 27 articles with a total number of 25,593 participants, examining nutritional supplementation, prophylactic medication, and equipment modifications with mostly high or unclear risk of bias. Meta-analysis and Grading of Recommendations Assessment, Development, and Evaluation assessment could be performed for 3 comparisons: custom-made insoles versus no insoles, tropical/hot-weather boots versus leather boots, and shock-absorbing insoles versus nonshock-absorbing insoles interventions, all showing the very low quality of evidence. Some evidence was found to support the preventive effect of shock-absorbing insoles, basketball shoes, padded polyester socks, calcium with vitamin D supplementation, only calcium supplementation, protein supplementation, and dynamic patellofemoral braces.

Conclusions: Although an evidence base for the efficacy of preventive interventions for musculoskeletal injuries in armed forces is weak, there are some indications for the preventive effect of shock-absorbing insoles, basketball shoes, padded polyester socks, supplementation of calcium alone or combined with vitamin D, protein supplementation, and dynamic patellofemoral braces on the incidence of musculoskeletal injuries.

Am J Prev Med 2021;60(2):e73−e84.

CONTEXT

Despite the benefits of physical exercise on mental and physical health,[1] the high physical demands of military training are associated with an increased risk of both acute musculoskeletal injuries (MSIs) as well as MSIs with a gradual onset.[2−4] Medical data from the U.S. Army show an MSI rate of 62.8 per 100 person-years.[5] According to medical data from the British Army, the incidence of MSIs varies

From the [1]Department of Epidemiology and Data Science, University of Amsterdam, Amsterdam, The Netherlands; [2]Department of General Practice, Erasmus MC University Medical Center, Rotterdam, The Netherlands; [3]Defence Healthcare Organisation, Ministry of Defence, Utrecht, The Netherlands; and [4]Amsterdam UMC, Research Support, Medical Library AMC, University of Amsterdam, Amsterdam, Netherlands

Address correspondence to: Iris Dijksma, MSc, Department of Epidemiology and Data Science, Amsterdam UMC Location AMC, University of Amsterdam, Room J1b. 219, P.O. Box 22700, 1100 DE Amsterdam, Netherlands. E-mail: i.dijksma@amsterdamumc.nl.

0749-3797/$36.00
https://doi.org/10.1016/j.amepre.2020.08.007

from 32.5% to 50.1% across several training companies.[6] The most common types of MSIs in armed forces are joint sprains, muscle strains, and other injury types that are also common in athletic populations, such as iliotibial band syndrome and stress fractures.[7,8]

Among military personnel, MSIs are the leading cause of high costs of medical care[9−11] and are related to limited-duty days,[9] which threaten military readiness.[8,10] Prevention of MSIs among military personnel is needed to decrease the demand for healthcare and associated costs and to increase military readiness. Previous recommendations for MSI prevention in armed forces have been suggested on the basis of 2 expedited reviews.[12,13] Aside from modifications of exercise programs, these recommendations suggested several nonexercise strategies for the prevention of MSIs, such as equipment modifications, prophylactic medication, and nutritional supplements. However, these reviews lacked a systematic approach to the reviewing process and did not assess the risk of bias of the included studies with a validated assessment tool nor considered this in the recommendations. In addition, no attempt was made to increase the precision of effect estimates by performing meta-analyses.

To strengthen the evidence base for decision making with regard to MSI prevention in armed forces, the authors performed a systematic review of RCTs evaluating the effectiveness of any nonexercise strategy for the prevention of MSIs in armed forces, including risk of bias assessment, meta-analysis, and a summary of findings through the Grading of Recommendations Assessment, Development, and Evaluation system.[14]

EVIDENCE ACQUISITION

This systematic review followed the methods as recommended by the Cochrane Handbook for Systematic Reviews[15] and is reported in accordance with the PRISMA statement.[16] The review protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO) (CRD42017062208).

The authors conducted a search in PubMed/MEDLINE, Embase (Ovid), Cochrane Library, CINAHL (EBSCO), and SPORTdiscus (EBSCO) up to July 5, 2019 (Appendix A, available online). The search used both index terms and text words for the components—*military personnel/armed force, musculoskeletal system, injury/fracture*, and *prevention*—without restrictions on source, publication date, language, and publication status. The authors searched the Greylit, Open Grey, and WHO trial registry to identify ongoing, recently completed, and unpublished studies. Additional records were identified through searching the reference lists of relevant articles.

Eligible studies were those employing an RCT or cluster RCT design, including military personnel in active service or recruits in military training, regardless of sex, rank, or occupational function, and those aged 15−60 years. Interventions of interest were those including equipment modification, nutritional supplementation, or prophylactic medication compared with those including ≥1 other intervention(s) or no intervention. To be included, studies were required to report the number of participants sustaining or incidence of any type of MSI or withdrawals from training owing to any type of MSI as primary or secondary outcomes. Injuries could be self-reported or diagnosed by a medical practitioner. If reported additionally as outcomes, limited-duty days prevented by the intervention, adverse events, side effects, and compliance with the intervention were also assessed. Conference abstracts were excluded, as were studies written in languages other than English or Dutch. The 2 review authors (IGA, ID) independently screened the titles and abstracts of identified records and examined full-text versions of potentially eligible articles. Review authors were neither blinded to authors of the articles nor to the institutions commissioning or conducting the studies.

Risk of bias in the included studies was independently assessed by 2 review authors (IGA, ID). Inappropriate analyses for cluster RCTs (i.e., not accounting for clustering or lack of adjustment for imbalanced baseline covariates) were considered as a source of (other) bias. Not accounting for dependent observations while reporting the number of MSIs (i.e., not applying multilevel analysis when a number of MSIs were reported instead of a number of participants sustaining MSIs) and possible conflict of interest owing to funding were also considered as a source of (other) bias. Disagreement was resolved by consensus, if necessary, followed by scrutiny of the last author (MMS).

The 2 review authors (IGA, ID) independently extracted data using a pretested data extraction form from the Cochrane Handbook[15] and resolved inconsistencies by consensus. Regarding the study outcomes, the rates of participants sustaining acute, overuse, and stress MSIs or the incidence of MSIs were extracted as primary outcomes. Clinic-reported injuries were used instead of self-reported injuries when both were reported. Adverse events, side effects, compliance with the intervention, withdrawals from training owing to MSIs, and limited-duty days prevented by the intervention were extracted as secondary outcomes.

Statistical analyses were undertaken using the Mantel−Haenszel method in Review Manager, version 5.3.[17] Authors reconstructed 2×2 tables on the basis of the reported number of events and analyzed participants in each group. In cases of ≥3 intervention arms in the trial, similar intervention arms were combined into a single group, and similar control arms (placebo and no intervention) were combined into a single control group for meta-analyses.[15] When data were considered clinically homogeneous regarding the content of the intervention, comparisons, study population, and outcomes, statistical pooling was performed using random-effects models, and treatment effects were calculated as RRs including 95% CIs. Statistical heterogeneity between the studies was assessed by visual inspection of the forest plots, Q-test, and I^2 statistics. For missing data owing to insufficient reporting, corresponding authors of the included studies were contacted. In cases of no response or absence of contact information, a narrative summary of the reported outcomes was provided instead.

Interventions were divided into the following categories: insoles, footwear, socks, nutritional supplementation, prophylactic medication, army vests, and bracing. Subgroup analyses within these categories were performed by identifying similar interventions within these categories, if appropriate, to account for clinical heterogeneity. In cases of statistical heterogeneity in the meta-analyses, post hoc sensitivity analysis was done by excluding trials that were considered a potential cause of heterogeneity on the basis of trial characteristics such as length of follow-up.

If meta-analysis was possible, the Grading of Recommendations Assessment, Development, and Evaluation approach was used to define the quality of evidence per category.[14,18−22] The starting grade of quality of evidence was of high quality because the results were obtained from RCTs and cluster RCTs. The reasons for downgrading the quality of the evidence are reported in the summary of findings tables.[14]

EVIDENCE SYNTHESIS

The search yielded 3,577 records, after removing duplicates. After screening on title and abstract, a total of 3,512 articles were excluded. The remaining 65 articles were screened on full texts, and 25 met the inclusion criteria. The main reasons for exclusions of full texts are detailed in Appendix B (available online). A total of 2 additional studies[23,24] were identified through searching the reference lists of articles (Figure 1). Of the included studies, 23 were RCTs and 3 were cluster RCTs. Two of the identified articles were reports on the same trial[25,26] and were used for data collection. Details of included studies are presented in Appendix C (available online).

In total, 25,593 participants were included in this review, aged 16−50 years, and employed as officer cadets, military recruits, and military personnel in active duty. Most trials included only male participants. A summary of the characteristics of the included studies is presented in Table 1 and summarized below.

Quality of the Evidence

Only 1 trial[27] was deemed to be free from any risk of bias (Figure 2). Risk of bias was often unclear owing to insufficient information. Reasons for the high risk of bias mostly included no blinding of participants and personnel. Details of the risk of bias assessment for each trial are shown in Appendices C and D (available online).

Within the 7 categories of interventions, there were limited opportunities to pool data owing to clinical heterogeneity. The results of pooling are shown in Appendix E (available online). Raw data were unavailable from 6 studies.[28−33] Attempts to obtain these data by contacting the authors were unsuccessful.

Insoles

A total of 5 trials[28,34−37] compared custom-made insoles with no insole during activities throughout military training with variation in the duration of wearing insoles from 1 hour per day to always. Raw data were available for 4 of these trials,[34−37] and pooled estimates of these (n=797) showed no significant reduction in the incidence of back and lower limb injuries in service conscripts, Naval recruits, and Air Force recruits (RR=0.74, 95% CI=0.41, 1.34, I^2=87%; Analysis 1). In an attempt to explain the substantial heterogeneity, the authors conducted a sensitivity analysis by excluding 1 trial[36] with a follow-up of 12−14 weeks longer than the other trials and including only male participants, whereas the other trials included both male and female participants. This did not change the conclusion (RR=0.60, 95% CI=0.28, 1.26, I^2=82%; Analysis 1.2). The remaining trial[28] (n=610) without raw data and with a high risk of bias also reported no significant difference in ankle sprains and tenderness in the foot between the 2 groups in male recruits but did not provide an effect size. In addition, 1 of the studies[35] showed no significant difference between the groups in the number of duty days using intention-to-treat analysis.

A total of 5 trials[38−42] compared shock-absorbing insoles with nonshock-absorbing alternatives (nonshock-absorbing insoles[38] or no insoles[39−42]) during all basic military physical training sessions for the prevention of MSIs in male infantry and Naval recruits (1 study[42] did not report the sex of the recruits). Raw data regarding the primary outcomes of this review were available for 3 trials. The pooling of these 3 trials[38,41,42] (n=3,487) resulted in a point estimate that favored the intervention group, but the difference was not statistically significant (RR=0.69, 95% CI=0.44, 1.06, I^2=54%; Analysis 2). A total of 1 trial[38] within this meta-analysis compared insoles with nonshock-absorbing insoles, and the other 2 trials[41,42] used no insoles in the control groups. Therefore, a sensitivity analysis was carried out by excluding this trial[38] to create a comparison of shock-absorbing insoles with no insoles. This showed a significant reduction in the incidence of stress fractures (RR=0.59, 95% CI=0.44, 0.79, I^2<1%; Analysis 2.2). No raw data and effect size were available for 1 trial[39] (n=1,511), with a high risk of bias, but the study authors reported that the mean weekly incidences of total overuse injuries and medial tibial stress syndrome were significantly lower in new military recruits when using shock-absorbing insoles than when using no insoles. No p-value or CI was reported; hence, the validity of this statement cannot be judged.

A total of 1 trial[40] (n=1,205), with a moderate risk of bias, compared withdrawals from training owing to MSIs between 2 different types of shock-absorbing insoles (Sorbothane and Poron) and between shock-absorbing insoles (Sorbothane and Poron together) and nonshock-absorbing insoles (Saran insoles) in Air Force male and female recruits. In that study, no significant effects were found (OR=0.85, 95% CI=0.58, 1.23 and OR=1.04, 95% CI=0.75, 1.44, respectively). For this review, all combinations of study arms of this trial were compared. Sorbothane and Poron insoles together

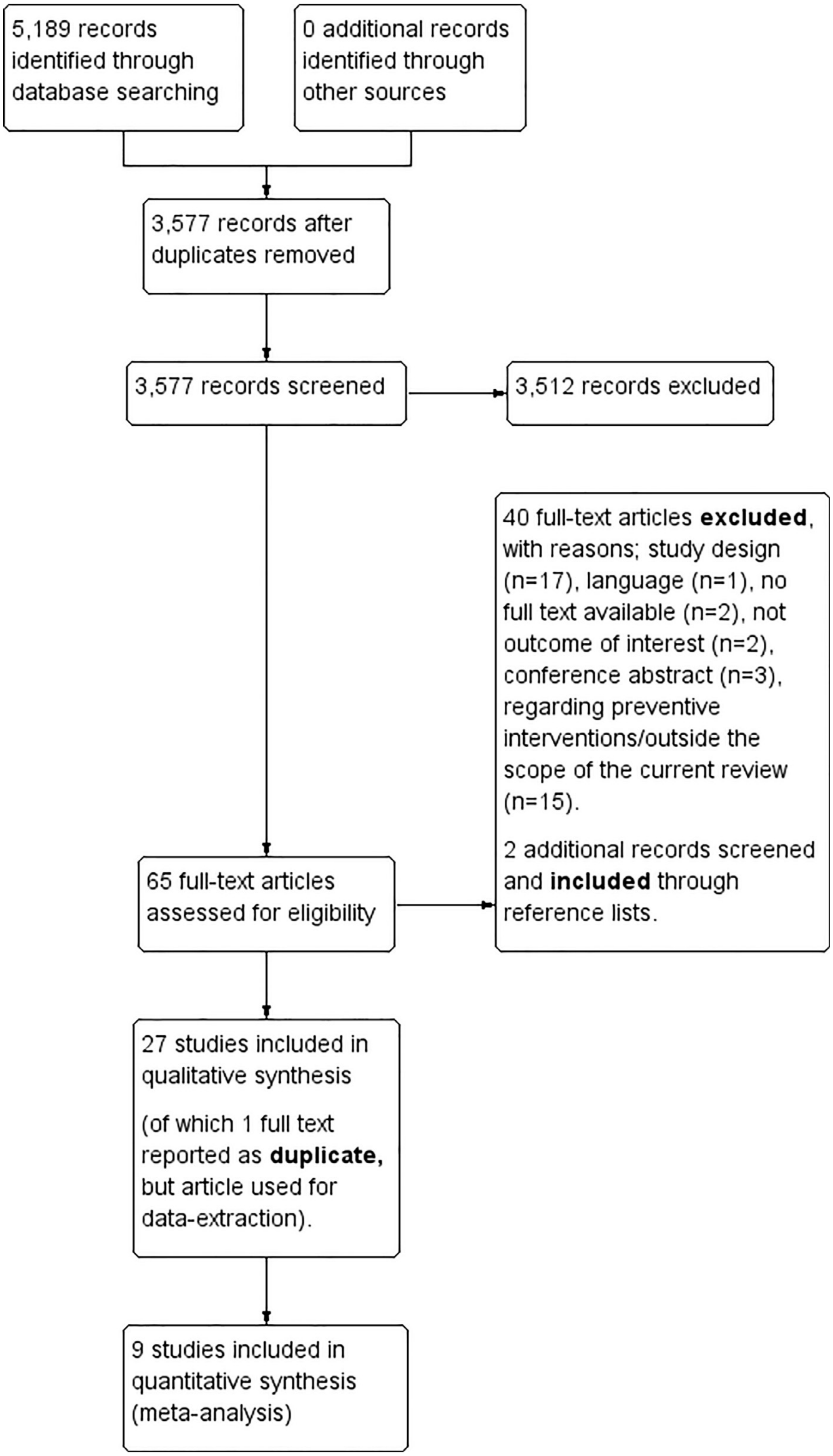

Figure 1. Flowchart of the inclusion and exclusion of articles in this review.

Table 1. Summary of Characteristics of Included Studies

Study	Study design	Recruitment setting	Sex	Age, years	Intervention; control	Duration of training, weeks	Outcome(s) of interest for the current review[a]	Relative effect (95% CI)
Insoles								
Esterman (2005)[34]	RCT	Royal Australian Air Force recruits with flat feet, Australia	Male and female	Not reported	Custom-made insoles (n=25); non-orthotics (n=22)	10	Incidence of back and lower limb injuries	RR=3.52 (0.42, 29.18)
Franklyn-Miller (2010)[37]	RCT	Britannia Royal Naval College military officer trainees, UK	Male and female	24–25	Custom-made insoles (n=200); no insoles (n=200)	7	Incidence of lower limb injuries requiring removal from physical training for ≥2 days	RR=0.34 (0.22, 0.54)
Hesarikia (2014)[28]	RCT	Military service recruits, Iran	Male	19–27	Custom-made insoles (n=300); no insoles (n=310)	8	Incidence of ankle sprains	Authors reported no significant difference between the 2 groups, but did not provide an effect size
Larsen (2002)[35]	RCT	Military service conscripts, Denmark	Male (n=146) and female (n=1)	18–24	Custom-made insoles (n=77); no insoles (n=69)	12	Incidence of back and lower limb injuries	RR=0.60 (0.28, 1.26)
Mattila (2010)[36]	RCT	Military service conscripts, Finland	Male	18–29	Custom-made insoles (n=73); no insoles (n=147)	24	Incidence of back and lower limb injuries	RR=1.22 (0.89, 1.68)
Finestone (1999)[41]	RCT	Defense Forces Medical Corps Infantry recruits, Israel	Not reported	17–27	Shock-absorbing insoles (n=126); no insoles (n=71)	14	Incidence of stress fractures	RR=0.47 (0.26, 0.86)
Gardner (1988)[38]	Cluster RCT	Marine Training Center recruits, U.S.	Male	18–41	Shock-absorbing insoles (n=1,557); nonshock-absorbing insoles (n=1,468)	12	Incidence of stress fractures	RR=1.16 (0.62, 2.20)
Milgrom (1985)[42]	RCT	Military Infantry recruits, Israel	Male	Not reported	Shock-absorbing insoles (n=143); no insoles (n=152)	14	Incidence of stress fractures (femoral, tibial, and metatarsal)	RR=0.63 (0.45, 0.89)
Schwellnus (1990)[39]	RCT	New military recruits Setting: not reported	Not reported	17–25	Shock-absorbing insoles (n=49); no insoles (n=317)	9	Incidence of overuse injuries Compliance to the intervention	No raw data reported, but the authors reported that the mean weekly incidence of total overuse injuries and medial tibial stress syndrome was significantly lower using shock-absorbing insoles 93.6% of the participants were compliant to the insoles
Withnall (2006)[40]	RCT	Air Force recruits, UK	Male and female	16–35	Shock-absorbing Sorbothane insoles (n=421); nonshock-absorbing Saran insoles (n=401) Shock-absorbing Sorbothane and Poron insoles (n=804); nonshock-absorbing Saran insoles (n=401)	9	Withdrawal from training for lower limb injury	RR=0.97 (0.72, 1.30) RR=1.11 (0.83, 1.48)
Bonanno (2017)[27]	RCT	Royal Australian Navy Recruit School recruits, Australia	Male and female	17–50	Prefabricated foot orthoses (n=153); flat insoles (n=153)	11	Incidence of lower limb injuries Incidence of adverse events	RR=0.68 (0.44, 1.04) RR=1.63 (0.96, 2.76)

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Table 1. Summary of Characteristics of Included Studies (*continued*)

Study	Study design	Recruitment setting	Sex	Age, years	Intervention; control	Duration of training, weeks	Outcome(s) of interest for the current review[a]	Relative effect (95% CI)
Finestone (2004)[43]	RCT	Defense Forces Medical Corps infantry recruits, Israel	Male	18–20	Prefabricated insoles (*n*=385); custom-made insoles (*n*=384)	14	Incidence of overuse injuries	RR=1.09 (0.91, 1.32)
Footwear								
Bensel (1976)[23]	RCT	Marine Corps Recruit Depot recruits, San Diego, U.S.	Male	Not reported	Tropical combat boots (*n*=372); leather combat boots (*n*=414)	12	Incidence of MSIs in the foot and lower leg	RR=1.02 (0.82, 1.27)
Bensel (1983)[24]	RCT	Army Training Center recruits, U.S.	Male	16–41	Black leather combat boots (*n*=1,771); hot-weather boots (*n*=1,070)	8	Incidence of MSIs in the foot and lower leg	RR=0.92 (0.69, 1.24)
Finestone (1992)[26] Milgrom (1992)[25]	RCT	Defense Forces Infantry recruits, Israel	Not reported	18–20	Basketball shoes (*n*=187); standard infantry boots (*n*=203)	14	Incidence of overuse injuries of the foot	RR=0.51 (0.36, 0.74)
Knapik (2009)[31]	RCT	Fort Jackson new army recruits, U.S.	Male and female	17–29	Foot shape–specific running shoes (*n*=1,979); regular (one type fits all) running shoes (*n*=1,973)	9	Incidence of traumatic and overuse lower limb injuries	Male RR=0.99 (0.86, 1.13) Female RR=0.96 (0.82, 1.12)
Knapik (2010a)[33]	RCT	Air Force Base recruits, U.S.	Male and female	18–19	Foot shape–specific running shoes (*n*=1,417); regular (one type fits all) running shoes (*n*=1,259)	6	Incidence of traumatic and overuse lower limb injuries	Male RR=1.09 (0.92, 1.30) Female RR=1.19 (0.96, 1.47)
Knapik (2010b)[32]	RCT	Basic Marine Corps Recruit Depot trainees, U.S.	Male and female	Not reported	Foot shape–specific running shoes (*n*=803); regular (one type fits all) running shoes (*n*=651)	12	Incidence of traumatic and overuse lower limb injuries	Male RR=0.99 (0.80, 1.22) Female RR=1.21 (0.94, 1.57)
Socks								
Van Tiggelen (2009)[44]	Cluster RCT	Officer cadets, Belgium	Male and female	Not reported	Padded polyester socks (*n*=65); regular army socks (*n*=65)	6	Incidence of overuse injuries of the knee	RR=0.54 (0.36, 0.81)
					Double-layer socks (*n*=59); regular army socks (*n*=65)			RR=0.58 (0.62, 1.17)
Nutritional supplementation								
Flakoll (2004)[46]	RCT	Marine Corps Base recruits, U.S.	Male	18.8–19	Protein supplement (*n*=130); placebo (*n*=128) and control (*n*=129)	7.7	Number of medical visits owing to MSI	RR=0.62 (0.43, 0.89)
Lappe (2008)[45]	RCT	Navy recruit volunteers, U.S.	Female	17–35	2,000 mg calcium and 800 IU vitamin D supplementation (*n*=2,626); Placebo (*n*=2,575)	8	Incidence of stress fractures	RR=0.82 (0.69, 0.97)
Schwellnus (1992)[30]	RCT	Military recruits. Setting: not reported	Male	<25	500 mg calcium supplementation (*n*=247); no supplementation (*n*=1,151)	9	Incidence of overuse injuries	RR=0.65 (0.50, 0.84)
							Side effects	No side effects

(*continued on next page*)

Table 1. Summary of Characteristics of Included Studies (*continued*)

Study	Study design	Recruitment setting	Sex	Age, years	Intervention; control	Duration of training, weeks	Outcome(s) of interest for the current review[a]	Relative effect (95% CI)
Prophylactic medication								
Milgrom (2004)[47]	RCT	New Infantry recruits known to be at high risk for stress fracture, Israel	Male	18–28	30 mg of risedronate (*n*=165); Placebo (*n*=159)	3	Incidence of lower extremity stress fracture Adverse reactions	RR=1.10 (0.64, 1.90) Authors reported no statistical difference of adverse events
Army vests								
Palmanovich (2017)[48]	Cluster RCT	Border Police Infantry recruits, Israel	Female	Not reported	New fighting vest (*n*=101); standard special unit fighting vest (*n*=139)	12	Incidence of stress fractures and overuse injuries of lower back, knee, and pain	RR=1.11 (0.99, 1.25)
Bracing								
Amoroso (1998)[50]	RCT	Airborne School recruits, U. S.	Male	≥18	Outside-the-ankle brace (*n*=369); No brace (*n*=376)	3	Incidence of MSIs, defined as any traumatic or musculoskeletal condition	RR=0.91 (0.47, 1.75)
Van Tiggelen (2004)[49]	RCT	Officer cadets without history of knee pain, Belgium	Male and female	17–26	Dynamic patellofemoral brace (*n*=61); no brace (*n*=139)	6	Incidence of anterior knee pain	RR=0.50 (0.27, 0.92)

[a]Most of the studies included evaluated a broad spectrum of outcomes, also including injuries beyond MSIs (e.g., blisters). In this table, only outcomes of interest for this review are presented. All outcomes of the studies included are presented in Appendix C (available online) *Characteristics of the included studies*.
MSI, musculoskeletal injury; UK, United Kingdom.

(*n*=804) compared with Saran insoles (nonshock-absorbing insoles; *n*=401) showed no significant effect in reducing withdrawal from training for lower limb injuries (149 vs 72, RR=1.03, 95% CI=0.80, 1.33). The comparisons of Sorbothane insoles (*n*=421) versus Saran insoles (*n*=401) (73 vs 72, RR=0.97, 95% CI=0.72, 1.30) and Poron insoles (*n*=383) versus Saran insoles (*n*=401) (76 vs 72, RR=1.11, 95% CI=0.83, 1.48) also showed no significant effect.

A total of 1 trial[43] (*n*=423), with unclear risk of bias, investigated the effect of prefabricated insoles compared with custom-made insoles during 14 weeks of basic training sessions on the incidence of MSIs in male infantry recruits. In the original study, 4 intervention arms were compared. This analysis merged the intervention groups into a prefabricated insole group and a custom-made insole group. On the basis of this analysis, prefabricated insoles showed no significant change in risk (RR=1.09, 95% CI=0.91, 1.32) compared with custom-made insoles. One other trial[27] (*n*=306), with a low risk of bias, compared prefabricated insoles with sham insoles to be worn daily during 11 weeks of initial defense training in male and female Naval recruits and also found no significant reduction of lower limb injuries (RR=0.68, 95% CI=0.44, 1.04). Participants who received prefabricated insoles experienced more adverse events (i.e., foot blisters, arch pain, and shin pain) than participants who received sham insoles, but the difference was not statistically significant (RR=1.63, 95% CI=0.96, 2.76). The pooling of these 2 trials was not possible owing to clinical heterogeneity.

In summary, although all evaluated types of insoles showed a protective effect on MSIs, in most cases, the differences were not statistically significant, and some adverse effects were also reported. There is however some evidence to support shock-absorbing insoles compared with no insoles in preventing stress fractures in infantry recruits.

Footwear

A total of 4 trials[26,31–33] evaluated the effect of foot shape–specific shoes. Pooling was not possible because of the lack of raw data of some trials[31–33] and clinical heterogeneity regarding treatment duration, physical activity sessions, and target population. A total of 3 trials[31–33] (*n*=6,033), with mostly unclear and high risk of bias, evaluated the effect of foot shape–specific running shoes with regular (one type fits all) running shoes on the reduction of lower limb injury rates during 6–12 weeks of basic combat training with 4–7 training days per week in new army recruits, Naval recruits, and Air Force recruits. Results were presented for men and women separately in all the trials. There were insufficient

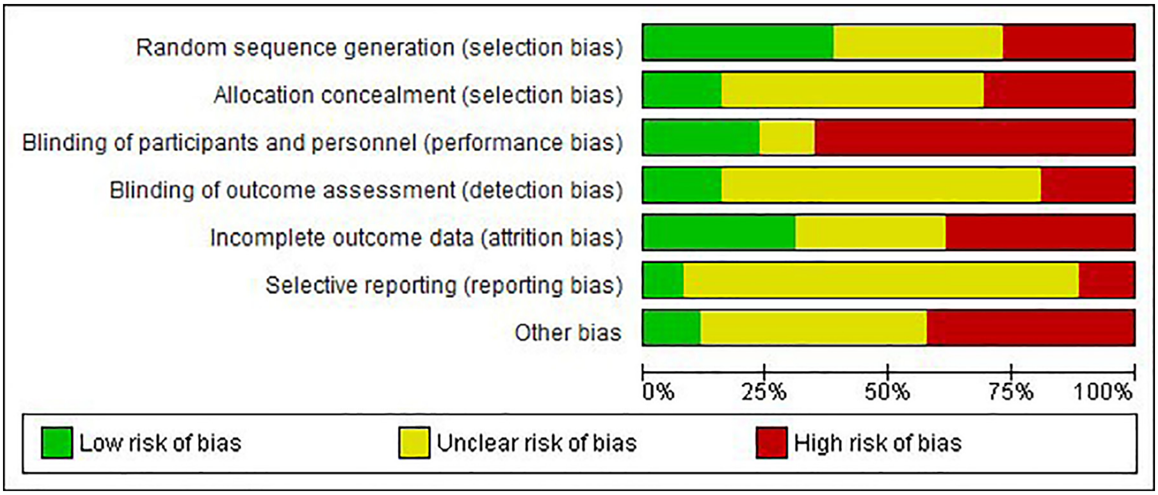

Figure 2. Risk of bias graph: review of author's judgments about each risk of bias item presented as percentages across all included studies.

data reported to recalculate RRs (95% CIs) for the intervention group compared with the control group for both sexes combined. The reported effects of the interventions varied over the 3 trials and were small (RR=0.96–1.21 for traumatic and overuse injuries); none were statistically significant. In the fourth trial[26] (*n*=390), with unclear risk of bias, basketball shoes were compared with standard boots in infantry recruits (sex not reported) during each training throughout 14 weeks of basic military training, which resulted in a significant reduction in the incidence of overuse injuries of the foot (RR=0.51, 95% CI=0.36, 0.74) in favor of basketball shoes.

A total of 2 trials[23,24] (*n*=3,627) compared the effect of tropical/hot-weather boots with that of leather combat boots on the incidence of foot and lower leg problems of male recruits during 8–12 weeks of basic military and Marine Corps training. As this outcome covered a broader spectrum than only MSIs, this analysis reconstructed 2 × 2 tables specifically for MSIs on the basis of the reported data. The pooled results showed no significant reduction of MSIs (RR=0.98, 95% CI=0.82, 1.17, I^2<1%; Analysis 3).

Socks

A total of 1 trial[44] (*n*=189), with a high risk of bias, compared 3 groups of male and female officer cadets with different types of socks during 6 weeks basic combat training: padded polyester socks, double-layer socks (a thin inner sock worn under a thick cotton–wool sock), and regular army socks. This trial did not report an effect size with RRs (95% CIs). The authors reconstructed 2 × 2 tables from the reported data to compare padded polyester socks (*n*=65) with regular army socks (*n*=65). This resulted in a significant beneficial effect of padded polyester socks on preventing lower limb MSIs (21 vs 39 MSIs, RR=0.54, 95% CI=0.36, 0.81). Likewise, double-layer socks (*n*=59) were compared with regular army socks, which showed a similar point estimate but was not statistically significant (30 vs 29 MSIs, RR=0.58, 95% CI=0.62, 1.17).

Nutritional Supplementation

A total of 3 trials[30,45,46] investigated the effect of different types of nutritional supplementation compared with that of placebo. Pooling of the results was not possible owing to clinical heterogeneity. A total of 1 trial[45] (*n*=5,201), with a moderate risk of bias, compared 2,000 mg calcium and 800 IU vitamin D with placebo in female Naval recruits and showed a significant reduction (RR=0.82, 95% CI=0.69, 0.97) of the incidence of stress fractures in favor of calcium and vitamin D supplementation. Another trial[46] (*n*=387), with mostly unclear risk of bias, compared protein supplementation with control and placebo in male Naval recruits. This analysis merged the control and placebo group (*n*=130) and compared this with the protein supplement group (*n*=257). This comparison showed a significant effect of protein supplementation in reducing the number of medical visits owing to MSI (27 vs 92 MSIs, RR=0.62, 95% CI=0.43, 0.89). A total of 1 trial[30] (*n*=250), with mostly unclear risk of bias, compared calcium supplementation with control in male recruits and showed a significant effect (RR=0.65, 95% CI=0.50, 0.84) in reducing the incidence of MSIs and no side effects in favor of calcium supplementation.

In summary, there is some evidence that nutritional supplements could be effective in reducing the incidence of MSIs and the number of medical visits owing to MSIs.

Prophylactic Medication

A total of 1 trial[47] (*n*=324), with a moderate risk of bias, investigated the effect of prophylactic medication (30 mg risedronate) in male infantry recruits known to be at high risk for stress fracture. This intervention is hypothesized to prevent the initial loss of bone during the remodeling response to high-bone strains against placebo. This showed no significant effect (RR=1.10, 95% CI=0.64, 1.90) in reducing the incidence of lower extremity stress fractures and no statistical difference in the incidence of adverse events between the 2 groups.

Army Vests

A total of 1 trial[48] (*n*=240), with mostly unclear risk of bias, compared a new fighting vest with a standard special unit fighting vest for female Border Police infantry recruits worn during basic military training of 4 months. This new fighting vest was designed as approximate to the female body center of gravity with the aim to provide better and more comfortable upper body fit, which was hypothesized to reduce the incidence of stress fractures and overuse injuries. The new fighting vest had no significant effect (RR=1.11, 95% CI=0.99, 1.25) on the prevention of clinic-reported stress fractures and overuse injuries.

Bracing

A total of 1 trial[49] (*n*=167), with a high risk of bias, compared dynamic patellofemoral bracing with no bracing in male and female officer cadets during 6 weeks of basic military training and showed a significant effect (RR=0.50, 95% CI=0.27, 0.92) in reducing the incidence of anterior knee pain in favor of the bracing group. Another trial[50] (*n*=745), with a low risk of bias, compared an outside-the-ankle-brace with no brace in male recruits during 3 weeks of a basic Airborne course. This trial reported a broad spectrum of injuries, including non-MSIs. When 2×2 tables of the incidence of MSIs were reconstructed and analyzed on the basis of the reported data, no significant effect was observed (16 vs 18 MSIs, RR=0.91, 95% CI=0.47, 1.75).

Grading of Recommendations Assessment, Development, and Evaluation Assessment

This study assessed the quality of evidence for the 3 comparisons for which a meta-analysis was done: custom-made insoles versus no insoles,[34–37] shock-absorbing insoles versus nonshock-absorbing interventions,[38,41,42] and tropical/hot-weather boots versus leather boots[23,24] (Appendix F, available online). For all of these comparisons, the certainty of the evidence was very low.

DISCUSSION

Summary of the Main Results

This systematic review provides an up-to-date overview of the evidence regarding equipment modification, nutritional supplementation, and prophylactic medication for the prevention of MSIs in armed forces. Generally, the quality of the evidence is low and insufficient to make strong recommendations for practice. Nevertheless, some promising interventions were identified that seem worthy of further investigation. Shock-absorbing insoles compared with no insoles might reduce MSIs in male infantry and Naval recruits through improving shock attenuation at the foot−ground interface.[41,42] Basketball shoes instead of standard boots may be effective in preventing overuse injuries of the foot in infantry recruits through better-constructed shoes conforming to the foot.[26] Some supportive evidence was found for padded polyester socks instead of regular army socks in male and female officer cadets through the prevention of painful blisters that may indirectly result in MSIs through unusual loading of the musculoskeletal system.[44] There was also some supportive evidence for the preventive effect of calcium alone or combined with vitamin D supplementation in female Naval recruits. Vitamin D regulates the active transport mechanism of calcium absorption from the gut, and calcium is essential for bone mineralization and maximal bone adaptation to mechanical loading.[45] Similarly, protein supplementation was effective in reducing the number of medical visits owing to MSIs in male Naval recruits because postexercise protein supplementation is known to improve muscle protein deposition.[46] Finally, wearing a dynamic patellofemoral brace reduced the incidence of anterior knee pain in male and female officer cadets.[49]

Although preventive effects were found for some interventions, these findings should be interpreted with great caution. Most reports on trials contained insufficient information to assess the overall risk of bias, which also caused restrictions for carrying out sensitivity analyses, including only high-quality studies. Moreover, most trials (75%) were assessed as being at high risk of performance bias owing to lack of blinding of participants or personnel to group assignment. This can be explained by the fact that many of the trials evaluated interventions for which participants or personnel cannot be blinded, such as visible modifications of equipment. Finally, the effects of preventive interventions on limited-duty days and occurrence of adverse events and side effects were often not reported and evaluated, which resulted in a lack of completeness of data for this review.

Agreements and Disagreements With Other Studies

A previous systematic review[51] examined the effectiveness of interventions for preventing lower limb soft-tissue running injuries among runners and military service personnel. Although direct comparison is complicated owing to heterogeneous populations included in that review, these findings are largely similar. One notable discrepancy occurred with regard to the effect of padded polyester socks compared with regular army socks on lower limb overuse injuries. On the basis of the same single study, this study's calculations yielded the same effect measure but with a smaller 95% CI, resulting in a statistically significant effect as opposed to the previously reported nonsignificant effect. Because the raw data used to reconstruct 2×2 tables were not reported in the previous review, the authors cannot explain this mathematical inconsistency. Furthermore, the current results are consistent with those found in the review by Wardle et al.[13] regarding prevention strategies for physical training−related injuries in the military. They too concluded that insoles in general were not effective in preventing stress fractures. However, they considered insoles in general, whereas this study considered shock-absorbing insoles versus no insoles in a separate analysis, which suggested that shock-absorbing insoles might be beneficial in reducing MSIs. This review adds to the current body of knowledge regarding other types of insoles, nutritional supplements, army vests, and knee braces as preventive interventions for MSIs in armed forces.

Limitations and Cautions for Interpretation

It is important to note that not all trials used the exact same definition of MSI, which is likely reflected by the observed heterogeneity. To take this into account, pooling was only done when studies were clinically homogeneous. This resulted in a limited amount of meta-analyses in this review. A more standardized, internationally accepted definition of MSI would improve comparability across trials for future research. In addition, most of the current findings are restricted to predominantly male participants; therefore, applicability to female populations may be limited. Moreover, given the wide variation in comparisons of the included trials, results should be interpreted with attention for the study arm conditions in the original trials. When considering the effects of shock-absorbing insoles and basketball shoes, it should be noted that these interventions were examined 21−35 years ago, whereas in the meantime, insoles and shoes have evolved. These findings may no longer apply to the currently available footwear. Furthermore, all studies included in this review examined single interventions. However, MSIs, and overuse injuries in particular, often result from the interplay of several factors, including contextual and personal factors. The complex etiology of MSIs in military populations may require a more comprehensive approach such as the one proposed by Scott et al.[52] in which a multiple intervention strategy, including leadership emphasis, surveillance and reporting, and modified physical training, reduced the overall incidence of overuse injuries. However, such complex interventions should also be evaluated in RCTs before recommending them for implementation. Finally, the authors were unable to make recommendations on utilization and cost effectiveness because trials did not incorporate economic evaluations or utilization costs of the interventions. Further research in this area would be justified to make more extensive recommendations about implementation of the effective interventions.

CONCLUSIONS

To date, there is limited high-quality evidence regarding preventive interventions for MSIs in armed forces. There are some indications for the preventive effect of shock-absorbing insoles, basketball shoes, padded polyester socks, supplementation of calcium alone or combined with vitamin D, protein supplementation, and dynamic patellofemoral braces on the incidence of MSIs, but the quality of this evidence is low. Further research on these and comparable interventions is warranted before recommendations regarding implementation can be made. In addition, a more standardized, internationally accepted definition of MSI is needed to improve comparability across trials for future research.

ACKNOWLEDGMENTS

The authors sincerely thank the authors of the included studies for sharing their research findings. In addition, the authors would also like to thank the reviewers and editors for their valuable comments.

None of the authors have a direct or indirect commercial financial incentive associated with publishing this article. All authors agree to be accountable for all aspects of the work.

All authors made a substantial contribution to the design, the drafting, and the revising of the manuscript and have read and approved the final version.

No financial disclosures were reported by the authors of this paper.

SUPPLEMENTAL MATERIAL

Supplemental materials associated with this article can be found in the online version at https://doi.org/10.1016/j.amepre.2020.08.007.

REFERENCES

1. WHO. Physical activity. Geneva, Switzerland: WHO. https://www.who.int/news-room/fact-sheets/detail/physical-activity#:~:text=years%20and%20above-,Should%20do%20at%20least%20150%20minutes%20of%20moderate%2Dintensity%20physical,%2D%20and%20vigorous%2Dintensity%20activity. Accessed August 11, 2020. Published February 23, 2018.
2. Jones BH, Canham-Chervak M, Sleet DA. An evidence-based public health approach to injury priorities and prevention recommendations for the U.S. military. *Am J Prev Med.* 2010;38(1 suppl):S1–S10. https://doi.org/10.1016/j.amepre.2009.10.001.
3. Knapik JJ, Graham B, Cobbs J, Thompson D, Steelman R, Jones BH. A prospective investigation of injury incidence and injury risk factors among army recruits in military police training. *BMC Musculoskelet Disord.* 2013;14:32. https://doi.org/10.1186/1471-2474-14-32.
4. Robinson M, Siddall A, Bilzon J, et al. Low fitness, low body mass and prior injury predict injury risk during military recruit training: a prospective cohort study in the British Army. *BMJ Open Sport Exerc Med.* 2016;2(1):e000100. https://doi.org/10.1136/bmjsem-2015-000100.
5. Hauret KG, Jones BH, Bullock SH, Canham-Chervak M, Canada S. Musculoskeletal injuries description of an under-recognized injury problem among military personnel. *Am J Prev Med.* 2010;38(1 suppl):S61–S70. https://doi.org/10.1016/j.amepre.2009.10.021.
6. Heagerty R, Sharma J, Cayton J, Goodwin N. Retrospective analysis of four-year injury data from the Infantry Training Centre, Catterick. *J R Army Med Corps.* 2018;164(1):35–40. https://doi.org/10.1136/jramc-2017-000777.
7. Sharma J, Greeves JP, Byers M, Bennett AN, Spears IR. Musculoskeletal injuries in British Army recruits: a prospective study of diagnosis-specific incidence and rehabilitation times. *BMC Musculoskelet Disord.* 2015;16:106. https://doi.org/10.1186/s12891-015-0558-6.
8. Cameron KL, Owens BD. *Musculoskeletal injuries in the military*. New York, NY: Springer; 2016. https://doi.org/10.1007/978-1-4939-2984-9.
9. Ruscio BA, Jones BH, Bullock SH, et al. A process to identify military injury prevention priorities based on injury type and limited duty days. *Am J Prev Med.* 2010;38(1 suppl):S19–S33. https://doi.org/10.1016/j.amepre.2009.10.004.
10. Teyhen DS, Shaffer SW, Butler RJ, et al. What risk factors are associated with musculoskeletal injury in U.S. Army Rangers? A prospective prognostic study. *Clin Orthop Relat Res.* 2015;473(9):2948–2958. https://doi.org/10.1007/s11999-015-4342-6.
11. Wyss T, Roos L, Hofstetter MC, Frey F, Mäder U. Impact of training patterns on injury incidences in 12 Swiss Army basic military training schools. *Mil Med.* 2014;179(1):49–55. https://doi.org/10.7205/MILMED-D-13-00289.
12. Bullock SH, Jones BH, Gilchrist J, Marshall SW. Prevention of physical training-related injuries recommendations for the military and other active populations based on expedited systematic reviews. *Am J Prev Med.* 2010;38(1 suppl):S156–S181. https://doi.org/10.1016/j.amepre.2009.10.023.
13. Wardle SL, Greeves JP. Mitigating the risk of musculoskeletal injury: a systematic review of the most effective injury prevention strategies for military personnel. *J Sci Med Sport.* 2017;20(suppl 4):S3–S10. https://doi.org/10.1016/j.jsams.2017.09.014.
14. Guyatt G, Oxman AD, Akl EA, et al. GRADE guidelines: 1. Introduction-GRADE evidence profiles and summary of findings tables. *J Clin Epidemiol.* 2011;64(4):383–394. https://doi.org/10.1016/j.jclinepi.2010.04.026.
15. Higgins JPT, Green S. *The Cochrane Collaborators. Cochrane handbook for systematic reviews of interventions*. Chichester, England: Wiley-Blackwell; 2017. https://training.cochrane.org/cochrane-handbook-systematic-reviews-interventions.
16. Moher D, Liberati A, Tetzlaff J, Altman DG, PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Ann Intern Med.* 2009;151(4):264–269. https://doi.org/10.7326/0003-4819-151-4-200908180-00135.
17. Songer TJ, LaPorte RE. Disabilities due to injury in the military. *Am J Prev Med.* 2000;18(3 suppl 1):33–40. https://doi.org/10.1016/s0749-3797(00)00107-0.
18. Guyatt GH, Oxman AD, Kunz R, et al. GRADE guidelines 6. Rating the quality of evidence−imprecision. *J Clin Epidemiol.* 2011;64(12):1283–1293. https://doi.org/10.1016/j.jclinepi.2011.01.012.
19. Guyatt GH, Oxman AD, Kunz R, et al. GRADE guidelines: 8. Rating the quality of evidence−indirectness. *J Clin Epidemiol.* 2011;64(12):1303–1310. https://doi.org/10.1016/j.jclinepi.2011.04.014.
20. Guyatt GH, Oxman AD, Kunz R, et al. GRADE guidelines: 7. Rating the quality of evidence−inconsistency. *J Clin Epidemiol.* 2011;64(12):1294–1302. https://doi.org/10.1016/j.jclinepi.2011.03.017.
21. Guyatt GH, Oxman AD, Montori V, et al. GRADE guidelines: 5. Rating the quality of evidence−publication bias. *J Clin Epidemiol.* 2011;64(12):1277–1282. https://doi.org/10.1016/j.jclinepi.2011.01.011.
22. Guyatt GH, Oxman AD, Vist G, et al. GRADE guidelines: 4. Rating the quality of evidence−study limitations (risk of bias). *J Clin Epidemiol.* 2011;64(4):407–415. https://doi.org/10.1016/j.jclinepi.2010.07.017.
23. Bensel CK. *The effect of tropical and leather combat boots on lower extremity disorders among U.S. Marine Corps recruits.* Fort Belvoir, VA: Defense Technical Information Center; 1976. https://apps.dtic.mil/sti/citations/ADA025938. Published 1976. Accessed August 11, 2020.
24. Bensel CK, Kish RN. *Lower extremity disorders among men and women in Army basic training and effects of two types of boots.* Fort Belvoir, VA: Defense Technical Information Center . https://apps.dtic.mil/sti/citations/ADA133002. Published 1983. Accessed August 11, 2020.
25. Milgrom C, Finestone A, Shlamkovitch N, et al. Prevention of overuse injuries of the foot by improved shoe shock attenuation: a randomized prospective study. *Clin Orthop Relat Res.* 1992(281):189–192. https://doi.org/10.1097/00003086-199208000-00030.
26. Finestone A, Shlamkovitch N, Eldad A, Karp A, Milgrom C. A prospective study of the effect of the appropriateness of foot-shoe fit and training shoe type on the incidence of overuse injuries among infantry recruits. *Mil Med.* 1992;157(9):489–490. https://doi.org/10.1093/milmed/157.9.489.
27. Bonanno DR, Murley GS, Munteanu SE, Landorf KB, Menz HB. Effectiveness of foot orthoses for the prevention of lower limb overuse injuries in naval recruits: a randomised controlled trial. *Br J Sports Med.* 2018;52(5):298–302. https://doi.org/10.1136/bjsports-2017-098273.
28. Hesarikia H, Nazemian SS, Rasouli HR, Kazemi HM. Effect of foot orthoses on ankle and foot injuries in military service recruits: a randomized controlled trial. *Biosci Biotechnol Res Asia.* 2014;11(3):1141–1148. https://doi.org/10.13005/bbra/1499.
29. Sharma J, Weston M, Batterham AM, Spears IR. Gait retraining and incidence of medial tibial stress syndrome in army recruits. *Med Sci Sports Exerc.* 2014;46(9):1684–1692. https://doi.org/10.1249/MSS.0000000000000290.
30. Schwellnus MP, Jordaan G. Does calcium supplementation prevent bone stress injuries? A clinical trial. *Int J Sport Nutr.* 1992;2(2):165–174. https://doi.org/10.1123/ijsn.2.2.165.
31. Knapik JJ, Swedler DI, Grier TL, et al. Injury reduction effectiveness of selecting running shoes based on plantar shape. *J Strength Cond Res.* 2009;23(3):685–697. https://doi.org/10.1519/JSC.0b013e3181a0fc63.
32. Knapik JJ, Trone DW, Swedler DI, et al. Injury reduction effectiveness of assigning running shoes based on plantar shape in Marine Corps basic training. *Am J Sports Med.* 2010;38(9):1759–1767. https://doi.org/10.1177/0363546510369548.

33. Knapik JJ, Brosch LC, Venuto M, et al. Effect on injuries of assigning shoes based on foot shape in air force basic training. *Am J Prev Med.* 2010;38(1 suppl):S197–S211. https://doi.org/10.1016/j.amepre.2009.10.013.
34. Esterman A, Pilotto L. Foot shape and its effect on functioning in Royal Australian Air Force recruits. Part 2: pilot, randomized, controlled trial of orthotics in recruits with flat feet. *Mil Med.* 2005;170 (7):629–633. https://doi.org/10.7205/milmed.170.7.629.
35. Larsen K, Weidich F, Leboeuf-Yde C. Can custom-made biomechanic shoe orthoses prevent problems in the back and lower extremities? A randomized, controlled intervention trial of 146 military conscripts. *J Manipulative Physiol Ther.* 2002;25(5):326–331. https://doi.org/10.1067/mmt.2002.124419.
36. Mattila VM, Sillanpää PJ, Salo T, Laine HJ, Mäenpää H, Pihlajamäki H. Can orthotic insoles prevent lower limb overuse injuries? A randomized-controlled trial of 228 subjects. *Scand J Med Sci Sports.* 2011;21(6):804–808. https://doi.org/10.1111/j.1600-0838.2010.01116.x.
37. Franklyn-Miller A, Wilson C, Bilzon J, McCrory P. Foot orthoses in the prevention of injury in initial military training: a randomized controlled trial. *Am J Sports Med.* 2011;39(1):30–37. https://doi.org/10.1177/0363546510382852.
38. Jr Gardner LI, JE Dziados, Jones BH, et al. Prevention of lower extremity stress fractures: a controlled trial of a shock absorbent insole. *Am J Public Health.* 1988;78(12):1563–1567. https://doi.org/10.2105/ajph.78.12.1563.
39. Schwellnus MP, Jordaan G, Noakes TD. Prevention of common overuse injuries by the use of shock absorbing insoles. A prospective study. *Am J Sports Med.* 1990;18(6):636–641. https://doi.org/10.1177/036354659001800614.
40. Withnall R, Eastaugh J, Freemantle N. Do shock absorbing insoles in recruits undertaking high levels of physical activity reduce lower limb injury? A randomized controlled trial. *J R Soc Med.* 2006;99(1):32–37. https://doi.org/10.1258/jrsm.99.1.32.
41. Finestone A, Giladi M, Elad H, et al. Prevention of stress fractures using custom biomechanical shoe orthoses. *Clin Orthop Relat Res.* 1999 (360):182–190. https://doi.org/10.1097/00003086-199903000-00022.
42. Milgrom C, Giladi M, Kashtan H, et al. A prospective study of the effect of a shock-absorbing orthotic device on the incidence of stress fractures in military recruits. *Foot Ankle Int.* 1985;6(2):101–104. https://doi.org/10.1177/107110078500600209.
43. Finestone A, Novack V, Farfel A, Berg A, Amir H, Milgrom C. A prospective study of the effect of foot orthoses composition and fabrication on comfort and the incidence of overuse injuries. *Foot Ankle Int.* 2004;25(7):462–466. https://doi.org/10.1177/107110070402500704.
44. Van Tiggelen D, Wickes S, Coorevits P, Dumalin M, Witvrouw E. Sock systems to prevent foot blisters and the impact on overuse injuries of the knee joint. *Mil Med.* 2009;174(2):183–189. https://doi.org/10.7205/milmed-d-01-8508.
45. Lappe J, Cullen D, Haynatzki G, Recker R, Ahlf R, Thompson K. Calcium and vitamin D supplementation decreases incidence of stress fractures in female Navy recruits. *J Bone Miner Res.* 2008;23(5):741–749. https://doi.org/10.1359/jbmr.080102.
46. Flakoll PJ, Judy T, Flinn K, Carr C, Flinn S. Postexercise protein supplementation improves health and muscle soreness during basic military training in Marine recruits. *J Appl Physiol (1985).* 2004;96 (3):951–956. https://doi.org/10.1152/japplphysiol.00811.2003.
47. Milgrom C, Finestone A, Novack V, et al. The effect of prophylactic treatment with risedronate on stress fracture incidence among infantry recruits. *Bone.* 2004;35(2):418–424. https://doi.org/10.1016/j.bone.2004.04.016.
48. Palmanovich E, Frankl M, Nyska M, et al. The effect of Army vest design on the occurrence of stress fractures and overuse injuries in female military recruits. *BMJ Military Health.* 2017;163(4):251–254. https://doi.org/10.1136/jramc-2016-000692.
49. Van Tiggelen D, Witvrouw E, Roget P, Cambier D, Danneels L, Verdonk R. Effect of bracing on the prevention of anterior knee pain—a prospective randomized study. *Knee Surg Sports Traumatol Arthrosc.* 2004;12(5):434–439. https://doi.org/10.1007/s00167-003-0479-z.
50. Amoroso PJ, Ryan JB, Bickley B, Leitschuh P, Taylor DC, Jones BH. Braced for impact: reducing military paratroopers' ankle sprains using outside-the-boot braces. *J Trauma Acute Care Surg.* 1998;45(3):575–580. https://doi.org/10.1097/00005373-199809000-00028.
51. Yeung SS, Yeung EW, Gillespie LD. Interventions for preventing lower limb soft-tissue running injuries. *Cochrane Database Syst Rev.* 2011;(7):CD001256. https://doi.org/10.1002/14651858.CD001256.pub2.
52. Scott SJ, Feltwell DN, Knapik JJ, et al. A multiple intervention strategy for reducing femoral neck stress injuries and other serious overuse injuries in U.S. Army Basic Combat Training. *Mil Med.* 2012;177 (9):1081–1089. https://doi.org/10.7205/milmed-d-12-00085.