Original Article

Effects of 8 weeks of military training on lower extremity and lower back clinical findings of young Iranian male recruits: A prospective case series

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Abstract

Background: In this prospective case series we have assessed the clinical effects of 8 weeks military training on the lower extremity of the recruits.

Materials and Methods: Military recruits who met the eligibility criteria and gave informed consent were entered into the study. They were asked to fill out a self-reporting pain and functionality questionnaire before and after their training. They were also examined by a physician before and after their military training. The questionnaire and examination were concentrated on three blocs: lower back, knee, and foot.

Results: Three-hundred and seventy-three study subjects were evaluated. The study showed that there is a significant difference in reporting lower back pain after the training compared to the rate of complaints prior to the training ($P < 0.001$), knee pain, and foot pain also increased significantly ($P < 0.1$ and $P < 0.0001$, respectively) The difference was most prominent in foot complaints. Physical examination also showed significant increase in lower extremity findings following the training ($P < 0.05$).

Conclusion: Our study shows that there is a need for a new approach to military training of male recruits in Iran in order to minimize the adverse health effects.

Key Words: Foot injuries, knee injuries, low back pain, military

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INTRODUCTION

In Iran, all young males older than age of 18 who are physically fit will be drafted into military service, every one of these recruits will have a 2-month training during which they receive basic military training; during this period there is a high emphasize on physical exercises which include and are not limited to: Endurance walks, military steps and navigation of rough train. This training is uniform for almost all recruits regardless of their physical ability.[1] In other countries, studies have been performed to assess the effect of the training on the overall health of the recruits and some have focused on the effects on and injuries of the lower extremity as it can considerably affect the rate of attrition, load-carriage ability, and overall health.[2-6] The most common lower extremity injuries noticed in military training are stress fractures which commonly affect the foot,

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although other bones of the lower extremity are also frequently involved. The most common complaint in people with stress fractures are localized pain in the lower extremity.[7,8] Other common complaints among military recruits include knee and back pain.

Many efforts have been made at identifying the risk factors for lower extremity injuries among military recruits, but to date a complete understanding of risk factors has stayed elusive.[6,9] Furthermore, there have been very few efforts to understand the effects of military training on young Iranian recruits especially as there are some unique features of military training in Iran. Because of this, we devised a prospective case series trial to assess the rate of lower extremity complaints in military recruits in Iran following 2 months of basic training.

METHODS AND MATERIALS

This was a prospective case series study performed during February and March of 2011 in a military training camp in Kermanshah; a province in western Iran. In this study a group of young male military recruits were asked to participate and a series of clinical variables were assessed in them in a before and after approach.

A total of 450 male military recruits were considered for enrolling in the study. The inclusion criteria consisted of any male over 18-years old who was recruited for military training. The exclusion criteria included the following: Any previous lower extremity fracture, any gait abnormality, any individual with severe limitation in straight leg rising (SLR) test, or any person with a condition that prevented rigorous training and physical activity. Out of the 450 individuals, 31 had one or more of the exclusion criterions and were excluded from the study. The information regarding the study was provided to the remaining 419 individuals and they were asked for consent to participate in the study. A total of 376 individual gave informed consent and were subsequently entered in the study.

The participant flow diagram has been shown in Figure 1. The participants were asked to fill out questionnaires on day one of their training and on day 55 of their training (last day of training). They were also examined by a physician on day one and day 55. A series of baseline characteristics including weight and height were also asked. The participants were asked to fill out detailed questionnaire before and after their training period; the questionnaire contained questions in three blocks with each block pertaining to lower back, knee, and foot, respectively. The low back pain was assessed using the STarT questionnaire.[10] Knee pain was evaluated using an adopted version of Knee injury and Osteoarthritis Outcome Score (KOOS) questionnaire.[11] The foot questionnaire was adopted from Foot Functionality Index (FFI).[12] The questions of each block were assigned weights based on a scale of 0-10 and an aggregate score of 0-10 was then assigned to answers provided by participants for each block; the aggregate score was calculated by a blinded trial clerk who multiplied the scores provided by participants to each question by the predetermined weight of the question and then added the weighted scores, the weights were determined so that the cumulative score would be between 0 and 10. The differences between the answers reported by participants before and after the training period were analysed using Paired T-test tool. The correlation of before and after scores was also examined by calculating the Pearson correlation coefficients.

The participants were also examined before and after the training period by a trained physician. The participants were again assessed in three blocks each block pertaining to either back, knee, or foot. For back examination straight leg raising test (SLR), reverse SLR, and point tenderness on lumbar vertebrae were assessed. For knee problems McMurray test, ligament tests (anterior drawer test, posterior drawer test, Lachman test, medial collateral ligament test and lateral collateral ligament test) and Shrug test were examined.[13] For foot examination; point tenderness

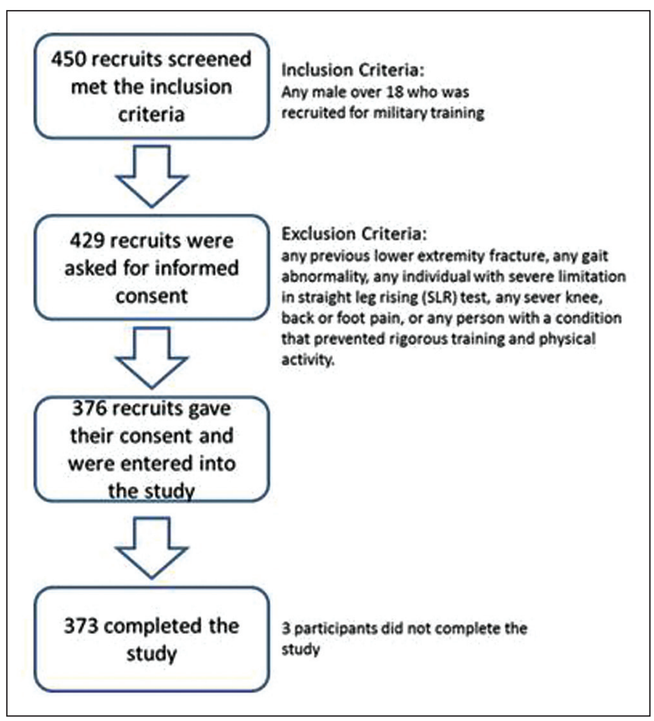

Figure 1: Participant flow diagram

in N (Navicular) spot,[14] neurovascular assessment and assessment of tenderness while toe hopping were used.[15]

If any of the examinations performed for each bloc was positive then the bloc examination was registered as positive (binary outcome). The differences in frequencies of reported positive blocs before and after the training were analyzed using McNemar test. The results were entered into a database and analyzed using SPSS.

RESULTS

Overall 376 male recruits were enrolled in the study. Among these individuals any who received a major trauma during the course of training leading to fractures, dislocations, hospitalization, or exemption from physical activity for more than 3 days was excluded from the final analysis. As a result three participants were later excluded from the analysis; one had a calcaneal fracture following a fall, one was hospitalized due to a bout of pneumonia and one failed to finish the training period. The results from the 373 participants were entered into database and there was no missing data.

The analysis of baseline characteristics showed that mean age of the participants was 22.38 years (SD: 1.86, 95% CI: 22.19-22.57). The mean height and weight of the participants were 1.73 m (SD: 0.08, 95% CI: 1.72-1.74) and 72.26 kg (SD: 9.80, 95% CI: 71.26-73.26), respectively. Based on the height and weight variables BMI was calculated for each of the participants with the average BMI being 23.98 kg/m^2 (SD: 2.80, 95% CI: 23.69-24.27).

Kolmogrov-Smirnov test showed that all of the baseline variables measured showed a normal distribution. Almost all of the participants were college educated with majority holding bachelor's degree (189 individuals, 50.67%), 143 individuals with some college education (Kardani, 38.33%) and 36 individuals with either a master's or doctorate's degree (9.65%) and a further 5 with no college education.

The participants' Lower Back evaluation showed the following results: The mean pain and functionality score reported by the participants prior to the training period was 1.17 (SD: 1.68) with 186 individuals reporting no pain or dysfunction at all (49.9%) and 20 participants reporting an aggregate pain and dysfunction score of greater than 5 (5.36%). The mean aggregate pain and functionality score reported by the participants following the training period was 1.38 (SD: 1.87) with 166 individuals reporting no pain or dysfunction at all (44.5%) and 24 participants with an aggregated pain score of more than 5 (6.4%). Paired T test shows that there is a significant difference between the two mean aggregates (Mean difference: 0.20 (95% CI: 0.09-0.32) with a $P < 0.01$) and Pearson analysis shows that the two variables are highly correlated with a correlation coefficient of 0.792 ($P < 0.001$). The lower back examination was positive in 39 individuals (10.5%) and the exam was positive in 60 individuals post training (16.1%). McNemar test showed significance increase in positive examination ($P = 0.02$). The breakdown of symptoms and signs reported at the end of the training is provided in Table 1.

The participants' knee evaluation showed the following results: The mean aggregate score from the questionnaires filled by the participants prior to the training period was 1.08 (SD: 1.81) with 221 individuals reporting no knee pain or dysfunction at all (59.2%) and 25 participants reporting an aggregate pain and dysfunction score of greater than 5 (6.7%). The mean aggregate knee pain and functionality score reported by the participants following the training period was 1.83 (SD: 2.25) with 156 individuals reporting no pain or dysfunction at all (41.8%) and 47 participants with an aggregated pain score of more than 5 (12.6%). Paired T test shows that there is a significant difference between the two mean aggregates (Mean difference: 0.75 (95% CI: 0.59-0.90) with a $P < 0.01$) and Pearson analysis shows that the two variables are highly correlated with a correlation coefficient of 0.732 ($P < 0.001$). The knee examination was positive in 36 individuals (9.7%) before to the training and the exam was positive in 60 individuals post training (16.1%). McNemar test showed significance increase in positive examination ($P < 0.001$). The breakdown of symptoms and signs reported at the end of the training is provided in

Table 1: Lower Back clinical findings before and following training, note that some participants may have had multiple findings

Findings from the self report questionnaire	Number (percentage of total number of participants)		
	Before	After	*P*-value
Radicular pain	31 (8.31%)	40 (10.7%)	0.004
Paraspinal pain	112 (30.02%)	137 (36.72%)	0.000
Limitation in movement	18 (4.82%)	21 (5.63%)	0.016
Other	14 (3.75%)	13 (3.48%)	1
Findings from examination			
SLR	7 (1.87%)	11 (2.94%)	0.008
Reverse SLR	3 (0.84%)	3 (0.84%)	1
Paraspinal tenderness	29 (7.77%)	54 (14.47%)	0.000
Point tenderness of spinous processes	9 (2.41%)	14 (3.75%)	0.004

Table 2. As for foot evaluation, prior to the training participants' mean reported aggregate score was 0.39 (SD: 1.02) with 296 (79.4%) reporting no pain and seven participants reporting an aggregate score of more than 5 (1.9%). At the end of the trial, the average reported aggregate score had increased to 1.37 (SD: 2.29) with 209 (56%) reporting no pain at all and 43 individuals reporting an aggregate score of more than 5 (11.5%). The paired T-test shows that the mean difference in the before and after scores is 0.98 (95% CI: 0.76-1.19) which was very significant ($P < 0.0001$), these score are correlated with a Pearson correlation coefficient of 0.37 ($P < 0.01$). Thirty-six participant (9.7%) had a positive finding in examination prior to the training while 69 (18.5%) had a positive exam finding at the end of the study. McNemar test showed significance increase in positive examination ($P < 0.001$). The breakdown of symptoms and signs reported at the end of the training is provided in Table 3.

The differences between the foot and Knee scores reported before and after the training showed no meaningful correlation with weight or BMI. But if a cut-off point of 25 was considered for the BMI of the participants, then in these individuals a positive linear correlation between knee and foot pain and BMI could be found. This indicates in those with BMI of over 25, the higher the BMI score the more likely they were to report a higher aggregate knee or foot pain after the training period. The Pearson correlation coefficient calculated for these individuals for differences in foot and knee pain was 0.302 and 0.336 respectively ($P < 0.01$). Back pain, however, showed no significant correlation with any of the baseline variables. In examination; individuals with a BMI of more than 25 were more likely to have a positive examination in lower back, knee, and foot examination ($P < 0.05$).

The difference in aggregate score for foot, knee, and back pain and dysfunction did not show a correlation with height. In the examination, as well, no effect of height on the positive reporting of findings in foot, knee, or back was witnessed. The results showed that knee and foot scores reported following the training have a positive linear correlation with the correlation coefficient of 0.11 ($P < 0.05$). No other meaningful correlations were observed.

DISCUSSION

Our findings show that the rate of lower extremity complaints rises significantly following 8 weeks of military training. While the average aggregate score among all recruits remains low with an average score

Table 2: Knee clinical findings before and following training, note that some participants may have had multiple findings

Findings from the self report questionnaire	Number (percentage of total number of participants)			Distribution between left and right extremities post training (Percentage of those affected by the complaint provided in parenthesis)		
	Before	After	*P*-value	Left knee	Right knee	Both
Pain on extension	72 (19.30%)	97 (26%)	0.000	55 (56.70%)	23 (23.71%)	19 (19.59%)
Pain on flexion	31 (8.31%)	41 (10.99%)	0.002	18 (43.90%)	10 (24.39%)	13 (31.71%)
Locking	13 (3.49%)	12 (3.21%)	1	4 (33.33%)	7 (58.33%)	1 (8.33%)
Clicking	4 (1.07%)	37 (9.92%)	0.000	15 (40.54%)	9 (24.32%)	13 (35.14%)
Pain on walking	40 (10.72%)	155 (41.55%)	0.000	69 (44.52%)	38 (24.52%)	48 (30.97%)
Findings from examination						
Ligament tests	13 (3.49%)	21 (5.63%)	0.008	9 (42.86%)	5 (23.81%)	7 (33.33%)
Shrug test	17 (4.56%)	58 (15.55%)	0.000	30 (51.72%)	12 (20.69%)	16 (27.59%)
McMurray test	6 (1.61%)	17 (4.55%)	0.001	5 (29.41%)	7 (41.18%)	5 (29.41%)

Table 3: Foot clinical findings before and following training, note that some participants may have had multiple findings

Findings from the self report questionnaire	Number (percentage of total number of participants)			Distribution between left and right extremities post training (Percentage of those affected by the complaint provided in parenthesis)		
	Before	After	*P*-value	Left foot	Right foot	Both
Metatarsal pain	25 (6.70%)	131 (35.12%)	0.000	80 (61.07%)	21 (16.03%)	30 (22.90%)
Heel pain	37 (9.92%)	55 (14.74%)	0.000	25 (45.46%)	21 (38.18%)	9 (16.36%)
Hyper/hypoesthesia	18 (4.83%)	71 (19.03%)	0.000	43 (60.56%)	17 (23.94%)	11 (15.49%)
Other	10 (2.68%)	22 (5.89%)	0.000	4 (18.18%)	7 (31.82%)	11 (50%)
Findings from examination						
Point tenderness in N spot	14 (3.75%)	61 (16.35%)	0.000	43 (70.49%)	6 (9.84%)	12 (19.67%)
Tenderness while toe hopping	15 (4.02%)	42 (11.26%)	0.000	26 (61.91%)	8 (19.05%)	8 (19.05%)
Neurovascular test	11 (2.95%)	7 (1.87%)	0.125	4 (57.14%)	0 (0%)	3 (42.86%)

of 1.38 for low back pain, 1.83 for knee pain and 1.37 for foot pain, they all show a significant increase over the pre training scores. This increase is most prominent for foot pain where the mean difference in before and after evaluation is around 0.98 (95% CI: 0.76-1.19) and least prominent for back pain where the mean difference is 0.20 (95% CI: 0.09-0.32). Our findings are consistent with similar studies performed in other countries which have pointed out foot stress fracture as the most common injury incurred during military training.[7,14,16-18] While the mean difference in the average pain and functionality score may not appear very large and relevant to clinical practice, the increase in number of individuals who reported a degree of pain or dysfunction has a clear clinical relevance. For example 26% of the participant reported a degree of foot pain or dysfunction prior to the training, but by the end of the training this had risen to 44%. Taking the considerable number of individuals enrolled each year in military training in Iran into account, this increase amounts to a significant health burden. The high rate of foot complaints among the soldiers has been addressed in other countries by improving the quality of the military boots provided especially by adding especially designed insoles to absorb the shock and force of extended walks and runs across rugged train to the foot. Studies have shown a significant improvement in the rates of injuries when improved insoles have been used.[19,20]

The examination results in our trial seem to mirror the pattern observed for the self-reported scores by the participants. There is a considerable rise in positive physical examination findings following the military training although the number of participants with positive examination is lower than the corresponding aggregate pain score; this disparity may be due to lower sensitivity of the examination for identifying problems as well as the propensity of the participants to exaggerate their problems.

In our study, the most common lower back complaint after the training was pain in the paraspinal region of the lumbar area with corresponding finding of paraspinal tenderness in the examination. Similar studies performed elsewhere have showed that the most common back injury among recruits is lumbosacral strain which is consistent with the findings of our study.[4,21-24] A study in Sweden found that back pain in military recruits may have a psychological aspect especially related to coping abilities;[25] this may partly explain for the low Pearson correlation coefficient for back pain and functionality aggregate score before and after training observed in our study.

In the knee, the most common findings in examination was the knee shrug sign this is in accordance with findings from similar studies which have reported patellofemoral pain syndrome as the most common cause of knee complaints among military recruits.[26-28] An interesting finding in our study was the relative imbalance in findings when comparing the right and left lower extremities. As shown in Tables 2 and 3, the complaints and positive examination findings were more frequent in the left lower extremity especially with reports of hyper/hypoesthesia of the foot, point tenderness in the left foot and left knee pain. We think that the goose step which is the official military marching step of the Iranian armed forces plays a role in this imbalance; the goose step involves hitting the left foot flatly and sharply on the ground for every 4th step. We suggest that further gait analysis is needed to clearly understand the forces incurred by the lower extremity during the goose step march and perhaps a revision can be made in the march in order to avoid the possible adverse health effects.

Studies have related the high incidence of lower extremity overuse injuries in military recruits to several factors; these include muscular fatigue, load carriage, military boots, hematological and inflammatory factor and pre training level of fitness. The incidence of overuse injuries in military recruits has in turn been shown to reduce the load carrying capacity of the recruits and their overall physical readiness which are major concerns in an active duty military and thus necessitate that these injuries are addressed in recruits.[6,9,19,29-31]

A growing body of evidence is pointing towards using stratification in military training.[32-36] In other words stratification of the recruits based on their baseline risk factors and their baseline physical ability and designing a physical activity regimen for each of the strata has shown to considerably decrease the rate of injury and attrition among recruits. In our study for example, we have shown that pre training aggregate scores as well as BMI of over 25 are strong predictors of post-training complaints and possible stratification based on these variables and/or other variables not checked in this trial can lead to a reduced rate of observed injuries, reduced attrition rates and a higher physical readiness in the recruits.[37] Other studies have suggested taking hematological and biochemical factors such as Vit D levels into account, while others have focused on Bone densitometry.[9,30,31] In other studies, it was shown that a physical ability test performed prior to the training and readjustment of physical activity level based on the findings can be effective in reducing the reported rate of injuries.

Recent studies have shown, however, that some of the skeletal complaints of military recruits may not affect their ability to complete the military training course or have long-term health effects on them; in a follow-up study 10 years following the report of tibial stress fracture in military recruits in United States, no patient reported any discomfort or limitation relating to the tibial stress fracture they sustained while in training 10 years prior. These studies suggest that while there is a need to address the immediate health effects of military training on recruits there is a limited fear for long-term effects and disability.[38]

In conclusion and based on our results, we believe that action is needed to reduce the rate of lower extremity injuries in military recruits in Iran; we suggest that training be adjusted according to risk stratification and we also recommend that a redesign of the military boots is undertaken to reduce the impact of the rigorous physical activity required of recruits on the lower extremities. We also acknowledge the fact that our study is lacking in relying solely on clinical findings and we suggest a further study with a larger study group using paraclinical tools such as X-rays in addition to clinical findings in order to improve the accuracy of the findings; these studies will help to shed light on the cause of the recruits' complaints.

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