**“Feet First”**

Orthotics Screening for Prevention of Lower Extremity Injuries

**Statement of Need**

Injury prevention has become an increasingly important topic across all military service branches due to the impact on manpower, finances, and healthcare. Basic training has been shown to have a high incidence of exercise or training related injuries due to the intense physical nature of the program. These training related injuries can account for 20-40% of outpatient clinic visits per month in some military branches.1 The high occurrence of injuries in basic training is leading to a substantial burden on the healthcare services causing increased waiting periods for initial consultations and shorter visits in outpatient clinics. The majority of training related injuries seen in the outpatient clinics involve the lower extremity.1 Therefore the development of a prevention program that targets lower extremity injuries could have countless benefits including: reduction of direct and indirect costs, loss of training days, program recycling, and healthcare strain.1

Although lower extremity injuries are the most frequently documented training related injury, the rates observed for different types of injuries differed between services and gender. For men in the Army’s basic combat training the top five injuries ranked, from highest to lowest: low back pain, tendinitis, sprain, muscle strain, and stress fracture.2 Women in the same program had an injury ranking as follows: muscle strain, stress fracture, sprain, tendinitis, and overuse knee injury.2 Women have also been proven to be more at risk for acquiring training related injuries (27-61%) compared to their male counterparts (14-42%).1 The military has discovered several intrinsic and extrinsic risk factors for training related injuries. One of the intrinsic factors is the trainees’ anatomy specifically the morphology of the foot and leg. Conditions such as pes planus, pes cavus, genu varum, genu valgum, genu recurvatum, excessive Q angle, and leg length discrepancies have all been proposed as potential risk factors but research supporting such claims is limited.

All military service branches wear combat boots during activities such as marching, obstacle courses, land navigation, training, and fighting.1 The fact that the combat boots have exhibited as an injury hazard provides a unique opportunity for intervention.3 The use of foot orthotics in combat boots of military trainees to help control abnormal biomechanics caused by lower extremity morphologies could reduce the incidence of lower extremity training related injuries.

“Feet First” is focused towards military recruits entering the Army service branch. The Army has the largest amount of entering recruits per year providing the program with the greatest opportunity for success.10 “Feet First” is not gender specific; the quanity of men and the predisposition of injury for women means both would benefit from screening and intervention.10

**Background**

Military bodies from all over the world are currently looking at the effects of footwear interventions on training related lower extremity injuries especially overuse injuries. Interventions under research are running shoe prescriptions4, use of shock absorbing insoles5, and fabrication of custom orthotics.6,7,8 There have been inconsistent findings regarding footwear interventions possibly due to the different types of interventions, small sample sizes, and methods of identifying at risk recruits.7

In a group of US Air Force recruits in basic training, the effects of prescribing running shoes based on plantar foot shape was evaluated.4 Foot shape was determined to be low, high, or normal arch height by assessment of a template taken while barefoot. The experimental group was given motion control, stability, or cushioned shoes for low, normal, and high arches respectively while the control group was provided stability shoe regardless. The study did not show any reduction in injury risk for the experimental group.4

Shock absorbing insoles have also proven unlikely to prevent lower extremity injuries in basic training.5 Air Force recruits from the United Kingdom participated in a randomized control trial with groups given either one of two different types of shock absorbing insoles or a non-shock absorbing insole.5 There was no difference between any of the groups regarding withdrawal from training due to lower extremity injury.5

More studies have been published recently on the effects of custom made orthotics for military recruits. One randomized control trial published in the United Kingdom demonstrated a significant risk reduction in recruits that received custom orthotics based on contact foot pressures during ambulation.6 Overuse injuries in which 2 days or greater were taken off from physical training was diminished from 1 injury per 1600 hours of training in the control to 1 per 4666 hours in the experimental group.6

Another orthotics study completed in New Zealand also revealed positive results.7 In a two arm feasibility study, recruits in the experimental group underwent a protocol examining adaptability of the foot (rearfoot posture, postural stability/balance, and forefoot stability).7 Based on the results, recruits received either no orthotics, orthotics without modification, or customized orthotics.7 There was a significant reduction in stress fracture of the foot, shin, and low back, plantar fasciitis, and chronic pain/discomfort of the hip, low back, and knee in the experimental group.7

Esterman and Pilotto specifically studied Royal Australian Air Force Recruits who displayed low arches.8 A three-quarter-length, flexible shoe insert was modeled for each recruit by an orthotist.8 The results were not statistically different in this study due to compliance of orthotic wear. However, the recruits that did wear their orthotics reported the least limb pain and highest quality of life. Of those recruits that wore the orthotics most or all of the time there was no cases of injuries related to training.8

Currently the literature does not support the use of prescribed running shoes or shock-absorbing insoles for prevent of lower extremity injuries. Custom biomechanical shoe orthoses on the other hand do appear to reduce injury rates in recruits across several studies. The exact method by which to evaluate recruits and the specific type of orthoses needed has yet to be determined. Common problems associated with compliance to orthoses are discomfort, slippage, and no perceived benefit. Wear schedules, increasing time worn by an hour each day, are not typically required for soft custom orthotics but could help with recruit adaptation and comfort.

There seems to be a correlation between custom orthotic use for at risk recruits and a reduction in overuse lower extremity injuries. Outcomes for the use of orthotics for prevention of injury become difficult when compliance issues are identified.8 Therefore the Health Belief Model of behavior change will be used in the “Feet First” program.9 The personnel providing the screening protocol and orthotic intervention will need to describe to the recruits their susceptibility to injury based on their screening results. Helping recruits understand the severity of some injuries and their consequences such as having to repeat the training and how the orthotics will reduce this threat should improve compliance. Personnel should also review potential barriers, orthotic slipping, and prescribe a wear schedule for the recruits to become accustom to the orthotic.9

**Assessment**

“Feet First” is a military based wellness program that focuses on reduction of lower extremity injuries in new military recruits entering basic training through the screening and provision of orthotics. The military is open to such initiatives due to the high incidence of training related injuries across all service branches and their effect on the military’s healthcare system and finances.1 It is estimated that training related injuries cost the military about $100 million annually.1 Therefore the Department of Defense has awarded a grant to finance this prevention program. Based on voluntary participation from many recruits in several research studies, the likelihood of involvement in this initiative is good.6,7,8

“Feet First” will be implemented in three stages: screening assessment, basic training, and an outcomes assessment. Outcome assessments would include low extremity injury (incidence rates), orthotic compliance (created form), foot health (Foot Health Status Questionnaire), and quality of life (SF-36).8 Lower extremity injury in this program is considered an injury in which the recruit has to be removed from training 2 or more days and has a verified ICD-9 diagnosis from a physician.6 Injury incidence rates would allow individual bases to compare the effect of “Feet First” in reduction of lower extremity injury with national or base statistics. Differences in injury incidence could also be evaluated in regards to compliance.

The Foot Health Status Questionnaire has adequate internal consistency, test-retest reliability, and construct validity and is a short 3-5 minute assessment of self-perceived foot health.11 Overall quality of life can be determined by the SF-36 which takes 5-10 minutes to administer and has good psychometric properties.12,13 The Foot Health Status Questionnaire and SF-36 would be given to the recruits: at initial orthotics screening and distribution (baseline), every 4 weeks during training, and then again on completion of training. The orthotic compliance form would be provided, along with the FHSQ and SF-36: every 4 weeks during training and on completion. With this schedule all service branches have at least one mid-intervention outcome measurements and the longer training programs having two. Having the compliance form supplied during the training period can serve as a cue to action for recruits that have forgotten or have not been wearing their orthotic consistently.9 Injuries would be surveillance through electronic medical records and incidence rates would be determined at the end of training.

**Program Goals and Aims**

The main goal of “Feet First” is to reduce the incidence of lower extremity injuries in the military population during Army basic training.1

Specific aims include:

* To identify at risk recruits by a screening protocol determining foot functional impairment.
* To implement the proper orthoses prescription based on the risk classification of the recruit.
* To demonstrate a reduction in lower extremity injuries at the end of Army basic training.
* To prevent loss of training days and program recycling.
* To demonstrate improved foot health and quality of life of the Army recruits that enrolls in the program.

**Proposed Intervention**

The “Feet First” program will be completed in three stages: screening assessment, mid-training assessment, and an outcomes assessment. Based on the initial three step screening protocol, the needs of each recruit will be determined individually and the appropriate orthotic intervention, if required, would be provided.7

**Site Parameters**

There are several possible sites for the “Feet First” program. The Army has six basic training centers across the country where the program can be started: Fort Benning, Ga; Fort Jackson,

SC; Fort Knox, Ky; Fort Leonard Wood, Mo; Fort McClellan, Ala; and Fort Sill, Ok.10 The reception battalion is where the recruits will finish their entrance processing and begin basic training.10 As part of the entrance processing procedure, recruits are issued uniforms and are fitted for various forms of equipment, such as gas masks, boots, and helmets.10 The screening process will take place at the same location where recruits are fitted for their boots. There are three steps to the protocol: screening, issue of orthoses, and questionnaires. An open area will be cleared for the screenings, a few chairs provided for those recruits being custom fitted, and several tables will be placed nearby for the outcome questionnaires. Healthcare professionals, such as physical therapists or other trained individuals, will perform the screening procedures.

**Intervention Phase I: Screening Assessment**

The screening assessment will have several purposes including identifying at risk recruits, distribution of orthoses, and determining participant baseline data. The first step will be the foot adaptability screening protocol which will determine the functional impairment risk for each individual recruit.7 A physical therapist, or another qualified healthcare professional, will administer the screening procedure which involves a three step sequential process: rearfoot posture, postural stability, and forefoot stability.7

*Screening Protocol*

The rearfoot posture will be assessed with the recruit in standing with bare feet and alignment will be determined by goniometric measurement of the heel in relation to the floor. The recruit will be scored from 0 to 3 by the measured rearfoot angle; 0-ideal rearfoot alignment (less than 4° eversion), 1- slight eversion (between 4° and 8°), 2- excessive eversion (greater than 8°), 3- inverted (greater than 4° inversion).7

Postural stability will be judged with the recruit standing on one leg and arms across the chest. Once balance is obtained, the recruit closes their eyes and the evaluator will assess balance and time the recruit. The combination of subjective and objective measurements will score the recruit from 0 to 4; 0-stable (foot stable and >30 seconds), 1-mild instability (foot unstable or oscillates and ≥30 seconds), 2-unstable (<30 seconds), 3-laterally unstable (lose balance off of the lateral aspect of foot), 4-grossly unstable (cannot maintain balance with eyes open).7

The recruit will then be evaluated for forefoot stability by standing on one leg and rising up onto their toes with eyes open. A score of 0 to 3 will be assigned to the recruit based on the forefoot stability; 0-smooth transition (stable, rolls forward), 1-unstable (completes but unstable), 2-resisted (difficult and may fall backwards), 3-inversion (ankle inverts).7

The recruit classification will be based off of the total score which is formed from the combination of the three test scores. Recruits with a score of 3 or less will be considered to not warrant an orthotic. Scores between 3 and 5 represent normal feet with mild functional impairment and will be given a prefabricated orthoses. Custom orthoses will be required for those recruits with significant functional impairments, scores above 5.7

*Orthotic Distribution*

After the identification of injury predisposition risk classification, the recruits that are willing to participate in the program will be allocated their assigned orthoses. The recruits with mild functional impairment will receive soft prefabricated orthoses based on shoe size from Tafnit Orthopaedics (Reshon Le Zion, Israel).14 The soft custom orthoses will be made by the same company via cast impressions. With the recruit sitting, the physical therapist, or trained healthcare professional, will press each foot into a foam containing box with the foot in the subtalar neutral position. A cast will then be formed from the impression on which the full length orthoses are molded.14 Both the prefabricated and the custom orthoses are made from a three layer material.14 Orthoflex comprises the outer and inner layers and Plasitzote the middle layer; both of which are made from closed cell cross-linked polyethylene (density = 1.3 g/cm3 and 1.125 g/cm3 respectively).14

*Baseline Measurements*

Only the recruits that are assigned to the orthotic intervention would be the required to complete the questionnaires. During the initial screening assessment the recruits would fill out the Foot Health Status Questionnaire and the SF-36.8 The FHSQ would provide baseline information regarding foot pain, foot function, footwear, and general foot health before the orthotic intervention and basic training.15 Functional health and well being scores of the recruits will be determined by the SF-36 questionnaire.16

**Intervention Phase II: Mid-Training Assessment**

The recruits involved in the program will be assessed midway through training using the Foot Health Status Questionnaire, SF-36, and a general orthotic compliance form. These measurements will provide additional data about the general foot and functional health of the recruits during the training period. The compliance form will be able to verify how many of the recruits are using their assigned orthoses.

**Intervention Phase III: Outcomes Assessment**

The last phase of the intervention will be the outcomes assessment at the end of the basic training period, about 8 weeks.10 The recruits that finish the basic training process in their assigned orthoses will complete the last round of forms: orthotic compliance form, the Foot Health Status Questionnaire, and the SF-36. Along with the final questionnaires, lower extremity injuries occurring during basic training will be checked for all of the recruits. The surveillance of lower extremity injuries will occur from review of electronic medical records. Injuries which cause 2 or more days off of training will be identified through physician diagnosed ICD-9 codes.6 Both the incidence rates for the recruits in the program as well as the cohort will be examined. The incidence of lower extremity injuries can then be compared to the base’s injury rates or to known Army training lower extremity injury incidence rates which has been shown to be around 37%.17 All measures will be taken into consideration when determining effectiveness of the program.

**Rationale for Intervention and Outcome Measurements**

The foot adaptability screening protocol has been shown feasible and effective in the New Zealand Army.7 The application of this screening protocol and distribution of orthoses resulted in a significant decrease in the majority of various lower extremity injury rates and a risk reduction in all types.7 The authors found that the evaluation method could be performed by military personnel with training, could be completed in a short period of time, and uses minimal equipment.7 Therefore the foot adaptability screening protocol is a low cost, quick procedure to identify at risk recruits and reduce lower extremity injury incidence during basic training.7

The Foot Health Status Questionnaire provides information about self-reported positive and negative health states.15 The FHSQ is comprised of four subcategories, foot pain, foot function, footwear, and general foot health which make the tool useful for many kinds of therapeutic and surgical interventions.15 The questionnaire only takes about 3 to 5 minutes to complete which is important to decrease responder burden since the recruits will be filling out several forms.15 An improvement in the FHSQ can be seen by an increase in the scale score; 0 represents poor foot health, 50 no problems, and 100 optimal.15

The SF-36 is a generic health measure that will supply self-reported physical and mental health perceptions.16 The SF-36 has been widely used in the literature to document change in functional health.16 The responder burden in greater for this measure, the form usually requires about 5 to 10 minutes to complete16. For recruits to be considered “somewhat better” a positive change of about 5 points will be required.16 For this program more emphasis will be paid to the physical health summary measure.

The incidence of lower extremity injuries is the primary outcome measure for this program. This will show the benefit of orthotic intervention by reducing injuries during basic training. Injury rate and incidence has been used as the main assessment tool for the orthotic research in the military population.6,7,8,14 Incidence rates of the participating recruits and cohort will be compared to known rates from either the specific base or combined statistics from the Army.

**Anticipated Outcomes**

The outcomes of the “Feet First” program at the end of the 8 weeks of basic training for Army recruits should show:

1. Improvement in foot and functional health as suggested by an increase of at least 5 points in both the Foot Health Status Questionnaire and SF-36 scores respectively.

2. At least 70% of recruits in compliance to orthotic assignment as indicated by a general compliance form.

3. Reduction of at least 20% in lower extremity injuries causing two or more days off of training as determined by surveillance of electronic medical records.

**Program Evaluation**

The purpose the “Feet First” program is to provide prophylactic intervention by means of shoe orthoses to military recruits whom are deemed at risk in order to decrease the incidence of lower extremity injuries. The evidence supporting orthotic use in the military is growing but no consensus on exact protocols has been deducted. Therefore the evaluation of “Feet First” results’ is extremely important to help confirm recent literature and promote more research in the future.

The effectiveness of the “Feet First” program will be evaluated upon completion by assessing the progress towards the anticipated outcomes. Goal one, “to demonstrate compliance to orthotic assignment,” will be assessed by examination of the mid- and post-intervention general compliance forms. These forms will indicate the percentage of recruits who have worn their orthoses most or all of the time with an anticipated goal of 70%. For goal two, “improve foot and functional health for at risk recruits during basic military training,” the outcome evaluation will be changes in the pre- and post-intervention scores on the Foot Health Status Questionnaire and the SF-36. The ideal change in these scores will be at least 5 points improvement indicating more optimal foot health and functioning. The third goal, “reduce incidence of lower extremity injuries sustained during basic military training,” will be evaluated by comparison of injury rates of the participants to the non-participating recruits. It is anticipated that correctly identifying at risk recruits and compliance to the orthotic regimen will result in a 20% reduction in lower extremity injuries. The injury rates of the participating recruits, or the entire cohort, can also be compared to rates from the specific base or the Army statistics. Through evaluation of the outcomes and how they have progressed towards the program’s goals, the “Feet First” program can be adapted and changed in order to provide more effective results.

The healthcare professionals and personnel completing the screening process, orthoses disbursement, and fabrication will be interviewed after entrance processing. Information about what aspects of the screening process went well and what areas is there room for potential improvement will be discussed. The subjective information from these interviews will allow for evaluation of the site parameters including setup and space requirements, need for personnel, time demands, and additional equipment needed. Optional surveys will be available for recruits to fill out at the end of training during the final outcomes assessment. The survey will include questions about opinions on the screening protocol, ease of orthotic wear, reasons for non-compliance, and an open ended section for general comments.

**Potential Barriers/Limitations**

The “Feet First” is a specialized program based on the United States Army’s basic military training schedule. Therefore adaptations would have to be made to the program in order to integrate the protocol into different service branches. The program in not currently designed for civilian use in outpatient orthopedic clinics. Hence the “Feet First” has limited application to other populations and settings.

There are a few potential barriers to the “Feet First” program. Due to the nature of the screening protocol there must be several healthcare professionals, or trained individuals, in order to screen all recruits, distribute prefabricated orthoses, fabricate the custom made orthoses, and direct/instruct recruits to fill out necessary consent forms and questionnaires. Therefore the base must be willing to provide the necessary staff on the day of entrance processing. Although the need for custom orthoses should be limited to a small sample, there is a possibility of longer waits and screening time or a backlog due to fabrication. The need for quick processing is essential in the basic military training atmosphere so efficiency is required for the program. Recruit comfort has been shown to be an issue with compliance to orthotic protocols.14 The use of soft orthoses should reduce dropout rates and improve compliance. Also the inclusion of only at risk recruits should diminish dropout rates due to no perceived benefit.14

**Relevance**

Training related or overuse injuries during basic training pose a major strain on the military’s healthcare and financial systems. The large percentage of training injuries and therefore outpatient clinic visits are for injuries of the lower extremity. The “Feet First” program attempts to reduce this burden by identifying those recruits with the highest likelihood of injury and providing prophylactic orthotic intervention. The use of orthotics can help facilitate normal biomechanics at the feet therefore decreasing abnormal alignment or pressures through the entire lower extremity. The “Feet First” program is designed after clinical research and provides a unique method of screening.7 The results from the program will add to previous research completed on orthotic programs in the military as well as the studies using this particular screening protocol. Future implementations of the “Feet First” program will be adapted based on the evaluation process to improve efficiency and effectiveness by addressing areas of identified weakness. The program can also be modified to fit other service branches equipment disbursement settings and training schedules due to the simple method of foot dysfunction screening and ease of access to outcome questionnaires.

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