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REVIEW ARTICLE

Prevention of Friction Blisters in Outdoor Pursuits: A Systematic Review

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The purpose of this systematic review was to determine if sock, antiperspirant, or barrier strategies were effective in prevention of friction blisters in wilderness and outdoor pursuits. A search of PubMed and EMBASE was conducted. Title, abstract, and full text articles were screened by 2 authors using predetermined inclusion and exclusion criteria to identify prospective controlled trials investigating prevention methods for friction blisters involving the foot. Only blisters associated with wilderness and outdoor pursuits (running, hiking, marching, etc.) were considered. Extraction of a predetermined data set was accomplished using a piloted form. Confidence in effect estimates were determined utilizing the Scottish Intercollegiate Guidelines Network methodology checklist. Literature search resulted in 806 discrete articles. After screening, 11 studies were identified for inclusion in systematic review. Included studies investigated 5 sock, 3 antiperspirant, and 3 barrier strategies. Only 2 articles were determined to have moderate confidence in effect estimate. Clinical and methodologic diversity precluded meta-analysis. Despite the high frequency, discomfort, and associated cost there is a paucity of high-quality quality evidence in support of socks, antiperspirants, or barriers for the prevention of friction blisters. Moderate confidence in effect estimate suggests that paper tape may be an effective form of barrier prevention.

Keywords: blister, friction, foot, running

Introduction

Friction blisters involving the foot represent a common injury in active individuals engaged in wilderness and outdoor related pursuits. Among long distance hikers and backpackers, reported blister rates range from 54 to 86%.[1,2] Studies involving military personnel report blister rates ranging from 5 to 77%.[3,4] Studies involving ultramarathon and adventure racing report blister rates ranging from 26 to 76%.[5,6] In fact, foot blisters have been cited as the most common medical complaint among hikers[7] and ultramarathon/adventure racers alike.[8–10] Although often regarded as a minor injury, the impact of friction blisters is not inconsequential. In competitive single-stage ultramarathons, Hoffman and Fogard reported 40.1% of finishers cited friction blisters as adversely affecting race performance.[5] A study of US Marine Corps recruits participating in initial training evolutions at Marine Corps Recruit Depot San Diego, CA, attributed an estimated annual expense of $690,000 to friction blisters.[4]

Friction blisters result from pressure and shear forces causing delamination at the level of the stratum spinosum.[11] Risk factors include but are not limited to moisture, temperature, external load, activity duration, characteristics of footwear, and adaptation/conditioning.[11–15] Each of these risk factors influence frictional force (F_f), where $F_f = \mu \times F_n$. Prevention and treatment strategies therefore seek to reduce the coefficient of friction (μ), pressure or shear force (F_n), frequency of force application, or any combination thereof. Such strategies include any combination of sock fibers, sock piles, sock layers, barriers such as tapes and plasters, antiperspirants, lubricants, and orthotics. Despite a multitude of published studies on the subject, friction blisters remain a common and debilitating injury among participants in wilderness and outdoor pursuits, and there remains no widespread consensus on effective prevention strategies.[14,16–18]

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We conducted a systematic search and qualitative analysis of prospective controlled trials to determine if sock, antiperspirant, or barrier strategies were effective in prevention of friction blisters of the foot in wilderness and outdoor pursuits.

Methods

Study design and methodology was predetermined through collaboration of all authors following guidelines in the PRISMA Statement for Reporting Systematic Reviews and Meta-Analyses.[19] Methods of analysis and criteria were documented in a written protocol in advance of the study.

SEARCH STRATEGY

Two electronic databases (PubMed, EMBASE) were systematically searched to identify prospective controlled trials investigating prevention strategies for friction blisters of the foot. The search strategy was formulated in collaboration with appointed university librarians from multiple institutions using a peer review process. No restriction on date or language of publication was applied. Details of this search strategy including discrete search terms utilized may be found in Appendix 1 (e-component). Database searches were conducted on May 20, 2016, and duplicates removed using EndNote citation manager software (Thomson Ruters, New York, NY). A secondary search of those references included in identified publications, and a tertiary search involving expert consultation, was subsequently conducted.

STUDY SELECTION

Two reviewers independently conducted title, abstract, and manuscript review using predetermined inclusion and exclusion criteria. Inclusion criteria consisted of the following: publications were original, prospective controlled trials (randomized controlled trial, prospective controlled cohort, case crossover, etc.); subjects were recreational or professional, military or civilian, engaged in wilderness and outdoor related activity (military evolutions, hiking, running, etc.); the intervention was for prevention of friction blisters (sock systems, liquid and powder antiperspirants, tapes, etc.); and outcome measures included incident data. All settings (desert, tropical, laboratory, etc.) were accepted. Exclusion criteria consisted of the following: case reports, case series, cross-sectional or descriptive studies; publications limited to abstract only; field- and water-based sports (soccer, basketball, rowing, etc.); blisters not of the foot; blisters created by artificial means or secondary to identifiable pathology (diabetes, vascular stasis, dermatologic conditions, etc.); and cases involving complication (infection, ulceration, chronic wounds, etc.). Reviewers remained blinded to results during review. A third reviewer subsequently mediated any dispute.

DATA COLLECTION

To assess diversity, a summary description of included full text articles was prepared utilizing a piloted form. Extracted data included the following: primary author and year of publication; study design; population (including mean age where provided); setting (including distance/time where provided); number of subjects; description of the intervention; outcome measures; and reported results (including incident data). In preparation for quality assessment, study design was determined using the Scottish Intercollegiate Guidelines Network Study Design Algorithm.[20] Studies were organized alphabetically within 3 groups based on intervention (socks, antiperspirants, or barriers).

Assessment of risk of bias and confidence in effect

Assessment of risk of bias and confidence in effect estimate was performed in the context of blister risk ratio with reference to the Cochrane Handbook for Systematic Reviews of Interventions[21] and utilizing the Scottish Intercollegiate Guidelines Network Methodology Checklist 2: Controlled Trials.[20] The checklist includes 10 elements for assessment of internal validity, including identification of a clearly focused question, method of randomization and concealment, blinding, similarity of treatment and control groups, outcome measure, dropout rate, intention to treat analysis, and comparability of results across sites where applicable. Minimization of bias in study design was coded as high, acceptable, or unacceptable (low) based on rater interpretation of relative risk, direction, and magnitude of bias effect. Only those studies determined to be of high or acceptable bias control were assessed for confidence in effect estimate. Risk ratio, confidence interval, and statistical significance for individual studies were calculated using MedCalc (MedCalc Software, Ostend, Belgium). A confidence in effect estimate was then determined through consideration of risk of bias, directness of evidence, consistency and precision of results, publication bias, and other identifiable methodological limitations. Confidence in effect estimates were coded as high, moderate, low, or very low in accordance with Grading of Recommendations Assessment, Development and Evaluation methodology.[22] Two reviewers who remained blinded