The South African Defence Force physical training programme

Part III. Exertion-related injuries sustained at an SADF basic training centre

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Summary

The incidence and nature of exertion-related injuries were studied at a South African Defence Force basic training centre. A total of 404 separate injuries were sustained by 359 of 947 recruits during the 10-week basic training cycle. Of these injuries, 16.3% were sustained with (group 1) and 81.7% without (group 2) an obvious sudden precipitating event. Exertion-related injuries were responsible for a loss of 2711 recruit-days of basic training. While the knee sustained the largest number of group 2 injuries, lower leg trauma resulted in the greatest loss of basic training time. Forty-two separate radiographically confirmed stress fractures were incurred by 39 recruits, an incidence of 4.12%, which is considerably higher than that in the US Army. These data leave little doubt that the present training programme is costly in terms of training time lost and may prevent large numbers of recruits from deriving the optimum conditioning benefits.

The excessive demands imposed on the musculoskeletal system during military training continue to be of utmost concern in today's more technologically oriented armed forces. This fact is most evident in the conditioning of new recruits making the sudden transition from civilian to military life who are subjected to an intensive programme of physical training during their initial months of military service (basic training). Besides imposing substantial medical costs, high rates of unnecessary and potentially avoidable injuries can prevent recruits from training for extended periods, as well as reduce the morale of the injured. In this respect, Cilliers and Gordon have recently suggested that the efficacy of South African Defence Force (SADF) basic training centres may be limited by the particularly injurious nature of the physical training used.

From years of experience with military physical training programmes, physicians, physicial educationalists and physical training instructors of the SADF have developed many provisional hypotheses for the aetiology and prevention of exertion-related injuries sustained during basic training. However, for a number of reasons, principally the lack of comprehensive and reliable descriptive data on the actual extent of the problem, these postulates have not been tested. Thus, for the most part, exertion-related injuries have been accepted as inevitable.

As an initial step to determine the true incidence and nature of these injuries, all exertion-related injuries sustained by the July 1982 intake at one SADF basic training centre were studied.

Subjects and methods

Definition of an injury

For the purpose of this study an injury was defined as one related to physical conditioning during basic training and severe enough to prevent the recruit from returning to normal activities for at least 1 day after medical consultation. This definition was chosen in order to exclude injuries that were: (i) trivial and did not result in loss of training time; (ii) sustained during the course of military training but not as a result of physical conditioning; and (iii) incurred by recruits on leave.

Classification of injuries

Injuries were classified further according to the presence (group 1) or absence (group 2) of an obvious sudden precipitating event. This classification was employed in preference to the more traditional 'extrinsic-intrinsic' categorization of injuries to avoid confusion arising over the role of various objects utilized during physical training (e.g. poles) in causing injuries.

Data collection

A 10-week cycle of basic training from July through September 1982 and involving 947 recruits was studied. The medical officers assigned to the basic training centre under investigation were required to complete a standard questionnaire for each recruit presenting to the unit's sickbay with an injury. In addition, the unit's medical records in which all sick reports are listed were consulted together with individual medical files when necessary to ensure the complete and accurate gathering of the required information.

The collected data were analysed to determine: (i) the overall number and incidence of injuries; (ii) their type; (iii) the anatomical site; and (iv) the basic training time lost as a result — this was calculated taking into account those days on which no basic training was performed for reasons such as week-end leave.

A radiographic diagnosis was required to confirm all stress fractures. These were subgrouped according to anatomical location

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and training date on which the diagnosis was first entertained by one of the unit’s medical officers.

**Results**

**Overall number and incidence of injuries**

A total of 404 separate exertion-related injuries were sustained by 359 recruits during the 10-week cycle. Group 2 injuries comprised the vast majority (81.7%), involving 307 recruits; group 1 injuries were incurred by 71 recruits and represented 18.3% of all injuries. The overall incidence of injury, expressed as a percentage of the total number of recruits engaged in basic training, was 37.9%, the incidence of group 1 injuries being 7.5% and group 2 injuries 32.4%.

**Anatomical sites of injury**

Of the 74 group 1 injuries, 21 involved the ankle, 16 the lower back and 11 the knee. The remaining 26 group 1 injuries were sustained at a variety of anatomical sites. Fig. 1 illustrates the number of group 2 injuries (330) at the various anatomical sites; these were confined almost exclusively to the lower limbs, pelvis and lower back. The knee sustained the greatest number of injuries (112), representing 33.9% of group 2 injuries and 27.7% of all injuries. The knee was followed in order of frequency of injury by the lower leg, achilles tendon, lower back, ankle, foot, heel, pelvis, thigh, neck and wrist.

**Loss of basic-training time**

Exertion-related injuries were responsible for a loss of 2711 (5.1%) out of a total of 53032 recruit-days of basic training (947 recruits multiplied by 56 days), the average time lost per injury being 6.7 days. Training time lost as a result of group 1 injuries was 432 recruit-days (5.8 days/injury) while group 2 injuries caused a wastage of 2279 recruit-days (6.9 days/injury). Fig. 2 shows the number of training days lost as a result of group 2 injuries located at the different anatomical sites. While the knee sustained the largest number of injuries, lower leg injuries caused the greatest loss of time (966 recruit-days or 35.6% of the total number of training days lost).

**Stress fractures**

Forty-two separate stress fractures were sustained by 39 recruits, an incidence of 4.12%, with a loss of 826 recruit-days. The relationship between the number of recruits presenting with clinical symptoms and signs suggestive of stress fracture, subsequently confirmed radiographically, and the weeks of the basic training cycle, is presented in Fig. 3. Peaks occurred during the 4th (7 recruits), 8th (10) and 10th (6) weeks. Fig. 4 shows the anatomical distribution of stress fractures. Tibial stress fractures were commonest (35); of these, 23 involved the proximal third, 4 the middle third and 8 the distal third. Femoral stress fractures were located at the femoral neck (1 subject), femoral shaft (2) and distal femur (2). Stress fractures were distributed fairly evenly between both legs, 19 in the right leg and 23 in the left.

**Discussion**

**Incidence of exertion-related injuries**

During the 10-week SADF basic training cycle 37.9% of recruits (359 of 947 recruits) sustained one or more exertion-related injuries severe enough to prevent their return to normal military training for at least 1 day after medical consultation.
Although considerable insight into the salutary effects of military physical conditioning programmes on recruit endurance fitness levels has been gained, little information is available concerning the associated risk of injury. In fact, a review of the available literature reveals only three substantial studies of the incidence of exertion-related injuries in military populations, all of which need further amplification to delineate the true magnitude of the problem. Kowal\textsuperscript{1} reported a 26% (202 of 770 recruits) and 62% (215 of 347 recruits) injury incidence for male and female US Army recruits respectively, who were participating in 8 weeks' co-educational basic training. While the average injury sustained by the women resulted in 13 days of lost training time, no data on time lost for males are available. However, for the purposes of his study Kowal\textsuperscript{1} defined an injury as 'any disability that was incurred during or as a result of physical training-conditioning which required attention from the medical facility' and it is likely that many of these injuries would not have qualified as injuries in the present investigation. Therefore, although a note of caution is appropriate, it does appear as though the SADF injury incidence compares unfavourably with that reported by Kowal\textsuperscript{1} for male US Army recruits.

However, a prospective study of US marines recorded a 37% incidence (325 of 879 recruits) of below knee injuries,\textsuperscript{2} and a recent study documented an alarming 65.4% incidence of 'work-related' injuries among New Zealand army recruits undergoing 10 weeks of basic training.\textsuperscript{3} Thus, while lack of documentation precludes an accurate scientific comparison of our findings with those of foreign armed forces, the present excessive injury rate is apparently not unique to the SADF. Any further speculation must be made with extreme caution.

**Overuse injuries during basic training**

The vast majority of exertion-related injuries in our study were sustained without an obvious sudden precipitating event and can, for practical purposes, be regarded as overuse injuries. The term 'overuse injury' is generally interpreted as the pain that ensues after excessive use of the musculoskeletal system during physical activity, including pain syndromes arising in normal structural anatomy as well as those that develop when structural abnormalities are unveiled by exercise.\textsuperscript{4} Constant repetitive stressing of the musculoskeletal system during exercise is thought to induce not only physiological adaptations which enhance performance, but also microscopic lesions in the involved tissues. Orava et al.\textsuperscript{5} suggested that this micro-trauma is due to disproportion between the strength of the musculoskeletal tissues and the total strain of physical training and ultimately summates to produce injury.

In the military, stress fractures have been recognized as the severest of overuse injuries since 1855 when Breithaupt,\textsuperscript{6} a military physician, described the oedematous painful feet of Prussian army recruits after long marches. In the USA an early indication of the magnitude of the problem was provided in 1967 by Morris and Blickenstaff\textsuperscript{7} when they reported on more than 700 recruits treated at one basic training centre during a 3-year period. An accurate assessment of the actual incidence of stress fractures among US army recruits was subsequently obtained in 1974 when a survey of all basic training centres revealed that 4.88% of trainees sought medical care for stress injuries of the bone.\textsuperscript{8} Although this incidence is slightly higher than ours (4.12%), it is noteworthy that the US Army survey provided an impetus to seek methods for the prevention of stress fractures among recruits. Recent modifications of their training programmes, based on a knowledge of the physiological response of bone to repetitive mechanical loading, have cumulated in an acceptable stress fracture incidence of approximately 1% among male recruits.\textsuperscript{9,10}

It should also be emphasized that the incidence as well as the anatomical locations of stress fractures in our study are limited by a variety of factors including failure to present for medical evaluation because of lack of symptoms or a strong desire to continue training, described as a consequence of physical well-being, the diagnostic capabilities of the centre's medical officers,\textsuperscript{11} and the use of radiographic diagnosis. Standard skeletal radiography requires an approximately 50% change in bone density for delineation and diagnosis of trabecular lesions.\textsuperscript{12} Stress fractures of trabecular bone may appear normal on radiographs for 10 - 21 days before resorption and proliferation associated with the healing process perceptibly increase bone density.\textsuperscript{13} A number of stress fractures incurred during the latter portion of basic training might thus have been missed. Moreover, a significant number of stress fractures require minimal new bone to support new forces and approximately one-half of all lesions fail to demonstrate any radiographic change.\textsuperscript{13} Thus, the use of a radiograph to confirm a diagnosis of stress fracture could have resulted in a large percentage of false-negative diagnoses thereby underestimating the actual incidence. The extent of this will only be established by employing skeletal scintigraphy as a diagnostic aid in a future study. Finally, we recognize that the incidence and location of stress fractures may differ from the present study in other SADF basic training centres. However, this investigation was only an initial step in determining the true state of the problem.

In civilian populations, overuse injuries are commonest after prolonged weight-bearing physical activities, and the anatomical locations of injury in this study are in fact similar to those observed in long distance runners.\textsuperscript{14} The finding that the knee was the most common site of injury, group 2 knee injuries accounting for 27.7% of all exertion-related injuries, is in close agreement with the 29% incidence reported by James et al.\textsuperscript{14} for civilian runners seeking medical treatment. Incidences of 25%,\textsuperscript{15} 41.7%,\textsuperscript{16} and 32%\textsuperscript{17} have also been documented for knee disorders among runners. The injuries in this study do, however, differ from those of runners in that lower back injuries comprised a relatively high percentage of the total. Although we did not intend to elucidate the precise cause of the various injuries, it seems likely that high rates of lower back injuries may be related to the practice of running while carrying heavy loads such as backpacks, poles and even fellow recruits, as well as the execution of calisthenics designed to strengthen the lower back muscles with incorrect technique. As regards overuse injuries in the lower limbs, James et al.\textsuperscript{14} have suggested that training errors, anatomical factors, shoes and surfaces are contributory in runners and it is probable that these criteria can be extrapolated to the military context.
Conclusions

This study has documented a disturbingly high incidence of exertion-related injuries at one SADF basic training centre. While it is not possible to make an accurate comparison, the incidence of stress fractures, one of the severest military exertion-related injuries, appears to be considerably higher in the SADF than in the US Army. Moreover, the present data leave little doubt that the injurious nature of the SADF programme studied is costly in terms of training time lost and may prohibit large numbers of recruits from deriving the optimum conditioning benefits. Experience from the US Army shows that the incidence of exertion-related injuries can be significantly reduced by simple and inexpensive techniques which do not impair the basic goal of producing physically conditioned soldiers.10

REFERENCES


Forget about hair analysis

It seems that in the USA there are a number of alleged laboratories which claim to analyse samples of hair and deduce all kinds of data about the patient from the analysis. A recent study of the commercial use of hair analysis in this manner suggests that it is unscientific, quite wasteful of money and probably illegal. In an article in JAMA (1985; 254: 1041) Barrett describes how hair samples from two healthy teenagers were sent under assumed names by a 'doctor' to 13 commercial laboratories performing hair analysis for mineral content. The reported levels of most of the minerals analysed varied considerably between identical samples sent to the same laboratory and from laboratory to laboratory. The laboratories also disagreed about what was normal for most of the minerals and most reports contained computerized interpretations that were obviously without a scientific basis. For example, reports on each of the subjects from one laboratory suggested that they had an excessive tendency to neuromuscular problems. Some laboratories suspected goitre or uraemia, together with depression of the central nervous system. Another listed, among the defects discovered, impaired carbohydrate metabolism, headaches, and a craving for sugar and alcohol.

Dermatologists will not be at all surprised to hear about these results but it is doubtful whether a report such as this will prevent the gullible public from wasting their money in this way.

Research on anti-AIDS agents

Although everyone agrees that finding a drug that will cure or arrest the progress of AIDS is going to be very difficult (and may prove impossible), several drugs are under investigation in the USA and France. A recent Medical News item (JAMA 1985; 254: 2521) notes progress as of November 1985 with four different agents — suramin, ribavirin, HPA-23 (a French agent), and axidothymidine (AZT).

Most experience has been with suramin, but the effects have been variable. The condition in some patients has continued to deteriorate while in others it has stabilized on therapy with the drug, although these patients are not any better. Suramin apparently suppresses viral replication, which is encouraging, but clinical results in parallel with this effect have not been shown. Experience with ribavirin is still very limited, although the agent has also been shown to suppress replication of the virus in patients.

Studies with the French agent HPA-23 have only just started in the USA. This drug, like suramin, inhibits the enzyme reverse transcriptase and is the agent which Rock Hudson went to Paris to be treated with. Clinical trialists at five centres in the USA (involving 80 - 100 patients) have begun phase one of studies with the drug.

AZT has shown interesting effects in the laboratory, but again it is too early to discuss clinical results.