TASK RELATED PHYSICAL FITNESS AND PERFORMANCE STANDARDS
-A CANADIAN FORCES APPROACH-

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FOR

BRIEFING TO
HUMAN RIGHTS COMMISSION
ON CF PHYSICAL FITNESS STANDARDS

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INTRODUCTION

1. Physical performance tests have, of course, been carried out in the Canadian Forces (CF) for many years. None, so far, have been entirely satisfactory. Based on the CF's desire to produce the best possible standards and programs for its personnel, a great deal of research and development has been funded and carried out in this area (Bibliography). This paper will briefly focus on the several varieties of physical fitness testing that have been employed by the CF.

2. Prior to 1972, a common physical fitness test for the CF was developed. This test battery included muscular strength and endurance, cardiovascular endurance, and agility component of physical fitness. This programme was discontinued after one and a half years because it was found that over-heavy stress was placed on simply passing the test, with little emphasis on development and maintenance of fitness. Further, test items could not be related by commanders directly to military tasks, and a lack of adequate preparatory programmes and poor screening resulted in a number of casualties during or as a result of testing.

3. After 1972, the procedure used to evaluate the fitness level of Forces personnel was a timed 1.5 mile run with age and gender related standards based on Cooper's work. Many personnel attempted this test without adequate training. A compulsory conditioning programme was introduced to train those personnel who failed the test, but the programme was generally poorly run and was even ignored at some units. As a result of problems stemming directly from participation in this test, the Surgeon General concluded that this method of fitness assessment carried an unacceptable risk level for participants aged 30 years and over and all fitness testing ceased in September, 1980. The 1.5 mile was, in any event, an unrealistic evaluation of general fitness since the minimum standard of performance could be achieved by individuals who were essentially sedentary but would spend a few weeks each year preparing for the run or even worse, not prepare at all. Further it provided little real indication of the soldier's ability or inability to meet occupational requirements in the field. The CF EXPRES Programme was subsequently introduced to safely assess the basic fitness level of CF personnel (References 1,2,3,4).

4. It has been said that the necessity for a high level of physical fitness for Canadian Forces personnel has never been questioned (5), and indeed the Forces requires its members to be alert, responsive, and both physically and mentally prepared for the unexpected. A soldier in a combat situation is required to perform a spectrum of physical activities ranging from long to short duration high intensity activities (6). Even in peacetime, soldiers must be capable of extremely demanding tasks, both in training for combat and in civil emergencies such as fighting forest fires or building sand bag dikes for flood control. Strangely, prior to 1991, there were no task specific physical fitness standards in the Canadian Army to determine if a soldier can meet these requirements.

5. Other than demonstrating a soldiers' ability to perform the occupational tasks adequately, optimal levels of physical fitness will provide many other benefits for the soldier. These include improved job efficiency, decreased accidents, injuries and sick leave, increased productivity and alertness as well as more positive work attitudes (5).

6. In a number of countries - the United States, Britain, Norway and France - studies have been carried out regarding the physical fitness of their military forces. In general, their findings have been similar to the results of Canadian studies: those personnel working in physically demanding jobs and participating in compulsory fitness training programmes were fit, while the remainder demonstrated a level of fitness similar to that of a generally inactive civilian population. And, as is well known, the maintenance of personal fitness in the Canadian Forces has been deemed to be a personal responsibility. The reality is that a great majority of Canadian Forces personnel are unfit and a significant percentage are also reported to be fat (7). That in itself emphasizes the necessity to establish realistic minimum performance standards for members of the Canadian Forces, standards which are task-specific and which can be tested effectively and objectively.

TASK RELATED PERFORMANCE STANDARDS

7. A review of other armed forces fitness standards indicate that they have been established by a process of "normative referencing" i.e., standards are based on fitness test scores of a certain upper percentile of the normal army population. Norm references have been established separately for each gender, age group, and type of unit assignment (combat or support), as these factors are known to influence fitness requirements for effective performance.

8. An alternative to "normative referencing" would appear to be establishment of standards based on the one need that can be objectively determined, i.e, the fitness requirement of the job itself. If an activity requires a certain level of performance capability as well as physical fitness, that requirement must remain the same irrespective of the gender or age of the soldier filling that position. This approach has been accepted by the Canadian military. The establishment of task related performance standards based on physical capacity has become a requirement both from an operational point of view as well as human rights legislation perspective.
In 1985, the CF briefed a human rights commission team on the process of the development of the model for the Minimum Physical Fitness Standard (MPFS) and received approval in principle. The model was later formalized and published as the CF method for the development of physical fitness standards (2, 4).

DEVELOPMENT OF THE CF
MINIMUM PHYSICAL FITNESS STANDARD

9. The following five steps were used in the development of the CF MPFS:

a. identification of the most physically demanding common tasks related to the operational requirements of the CF ;

b. identification of physical capabilities required to successfully complete the selected work tasks, and development and\or selection of appropriate laboratory tests which predict the capability to complete these tasks;

c. quantification of physical capacity required for completion of laboratory test and field task performance;

d. statistical analysis of data to determine population performance characteristics on different tests and predictive relationships among laboratory and field task variables; and

e. determination of acceptable level for the performance standards.

10. Stage One. This phase deals with identification of tasks and their sub components for the organization as a whole. The organizational structure may consist of many occupational specialties. Each occupation tends to consist of several jobs. For example the Canadian army (an occupation within the military organization) consists of four main job classifications: armour, infantry, artillery, and support staff. A job may involve several tasks. Some of the tasks involved in a job of an infantry soldier may consist of digging, casualty evacuation of another soldier of equivalent weight, weightload marching, jerry can lifting and carrying, and ammunition box lifting. Each task then can be subdivided into sub tasks which further consist of basic physical fitness elements. For example, the casualty evacuation task can be broken down in sub tasks: lifting another soldier and then running 100 m while carrying the injured soldier on shoulders and back. Elements consist of such factors as the loads involved in lifting or carrying, the frequency, duration, body postures, percent participation, and environmental factors which may be associated with the working conditions (8, 9).

11. The procedures for identification include: survey questionnaires, interviews, observation, and physical measurements. The survey questionnaire is used to rank order tasks according to qualitative task demands. Then the tasks are classified according to the physical demands such as strength, muscular endurance, anaerobic and aerobic demands (9, 10).

12. After task and component identification, most physically demanding common tasks representative of the work situation are selected with consultation of subject matter experts. The subject matter experts are experienced supervisors of the jobs who have an excellent working knowledge from a practical point of view as well as extensive observation of other workers' performances. It is assumed that if the individual workers are able to demonstrate their ability to perform more physically demanding tasks, they can also perform relatively less taxing tasks (e.g. lifting 30 and 20 kg). The selected tasks also should receive approval of the most senior administrators. Feedback from the subject matter experts and approval of the senior administrators allows greater face validity (11) to the selected tasks and also ensures acceptability of the set standards within an organization.

13. Stage Two. This stage involves identification of various physical fitness components required to perform the selected tasks. The factors most related to the work capacity are aerobic power and capacity, anaerobic power, anaerobic threshold, muscular strength and endurance. Once these components are identified, appropriate laboratory tests are developed and/or selected to quantify these components of physical performance. These tests should emphasize those components of fitness that are involved in the performance of the selected field (work) tasks (12). The purpose of the laboratory tests is three fold:

a. to validate the field tasks with the known valid laboratory tests of physical components;

b. to validate the laboratory tests against field tasks (cross validation); and

c. to predict field task performance based on the laboratory measures.

14. Stage Three. In this phase, the quantification procedures involve measures of laboratory test and field task performances. Representative workers, selected to develop the standards, perform these tests under simulated working conditions. The time to complete the task along with intensity of effort are the most important variables in determining ability to work. The relative oxygen uptake during the task also can be determined. For greater accuracy the oxygen uptake should actually be determined by measuring expired gases but it also can be estimated from heart rate using regression equations. For oxygen uptake prediction, regression equations should be developed from direct measures. The maximal strength and muscular endurance should be determined for those muscle groups which are most commonly used in actual working situations. Muscular endurance should be determined based on the load normally carried in the working situation. For example, if soldiers lift a 21 kg ammunition box, the relevant laboratory test (such as arm flexion or trapezius lift endurance test) should be performed with a similar load. This results in maximal predictability of field performance. The maximal aerobic power capacity, anaerobic power, and anaerobic threshold (13) also should be quantified.

15. Stage Four. This phase involves statistical analysis of data. Descriptive data such as frequency distribution, mean, standard deviation, standard error, and range of scores should be determined and compared to other populations reported in the related literature.

16. The next step is the calculation of Pearson product moment correlation coefficients between laboratory and field variables. The raw data should be plotted to make sure linear combinations exist before computation of correlation coefficients. If they are non-linear, then appropriate data transformation procedures should be utilized before computing these coefficients (11). Correlation coefficients determine the relationship among variables. They also are helpful in reducing number of variables for multiple correlations and canonical correlations to insure adequate subject/variable ratio in order to have confidence in the results (11).

17. After elimination of the non-relevant variables, multiple correlations and stepwise regressions equations should be obtained. Multiple correlations are determined by relating a set of laboratory variables with a given field variable. Similarly the multiple correlation and stepwise regression equation should be determined for field tasks predicting performance of each laboratory test. The main purpose of this analysis is to determine individual laboratory performance profiles based on the suggested performance standards of the field tasks. These profiles should be examined in order to determine if workers have physiological capabilities to meet the job requirements.

18. To obtain greater degree of confidence in the results, the factor analysis of the laboratory and field variables should be obtained. This determines how different tests tend to group together. For example, the laboratory and field tests may primarily load on a single factor indicating a very high relationship among the two sets of variables.

19. Canonical correlation between the set of laboratory and filed tests should also be obtained. This gives an indication of how the selected laboratory tests relate to the performances of all the field tests combined.

20. Stage Five. This stage involves setting up desirable physical performance standards. One way of setting a task related standard is through establishment of predictive relationship between laboratory and field variables. If the laboratory tests relate highly to the field task performance then they may be of most practical use. Such tests may be easy to administer, less time consuming, and require very little or no extra equipment. However, if the laboratory tests show non-significant relationship with the field task performance, then task specific standards must be utilized. Where only a few of the tests show high correlations with the field task performance a combination of two approaches also could be utilized.

21. To determine a cut-off point for an acceptable performance standard a combination of two approaches should be used. First, when collecting the data a panel of experienced subject matter expert judges should be established. This panel should watch the performance of each field task very carefully and determine, based on the occupational requirements, which ones they believe are pass or fail performances. Once this process is completed, then the panel of judges should decide collectively if they unanimously agree on possible standards of performances. Once an agreement is reached, then these suggested performances should serve as a guide to establish cut-off points for task related standards. However, if they do not agree then they follow the observation procedures again and evaluate their pass and fail performances until a collective agreement is reached. This procedure is necessary to establish criterion (non-normative) related task standards.

22. The cut-off performance time suggested by the panel should be confirmed using discriminant analysis for correct classification of data into pass and fail groups (11). The suggested performances also should be validated against the physiological data collected in the laboratory tests and compared against the related literature to ensure that the workers can physiologically meet these requirements. If the suggested level of acceptable performances by the expert panel is in agreement with the discriminant analysis and physiological findings then these may be accepted as standards of performance. However, if discriminant analysis and physiological data do not support the findings of panel of experts then some subjective adjustments to the cut-off points needs to be made until there is an agreement among all three.

PREDICTOR TEST

23. The major limitation of a task based physical performance test is the length of time and number of people required for its administration. Therefore, in most cases, a predictor test is required. The predictor test that was developed for the CF MPFS is called the CF EXPRES programme.

24. The CF EXPRES Programme. The CF EXPRES (Exercise Prescription) evaluation was derived from the Canadian Standardized Test of Fitness (14). CF EXPRES Programme consists of four components (15):

a. a pre-test screening designed to ensure the absence of health risk factors prior to testing (this screening includes a health appraisal and analysis of resting blood pressure and heart rate);

b. a physical fitness evaluation consists of an aerobic, muscular strength, upper and lower body muscular endurance, and body composition measurements;

c. an exercise prescription consists of individually tailored physical fitness training programme based on evaluation results of sufficient frequency, duration and intensity to ensure improvement or maintenance of physical fitness (unit training programmes can be used as part of the prescription); and

d. training (the primary objective of the programme is to promote habitual participation in effective training programmes).

25. In the fitness evaluation the measurement of muscular strength is the sum of the right and left hand maximal handgrip force as measured with an isometric dynamometer. The number of push-ups and sit-ups that can be completed in one minute measures muscular endurance. The maximal oxygen uptake (VO2max) is predicted indirectly from the measurements of heart rate during a sub-maximal step-test.

26. The EXPRES test is reported to be a reasonable measure of general physical ability (16), and is considered to be appropriate for gross fitness evaluation for large populations. Bell and Jacobs (17) indicates, however, that it may not be sufficiently sensitive to detect minor improvements in fitness that may occur as the result of a training programme (17). In their study, after 12 weeks of hydraulic resistance training, laboratory tests indicated significant improvements in measured fitness variables of participants; the EXPRES did not, however, detect these changes.

27. In the opinion of the authors' the CF EXPRES Programme will meet most general fitness evaluation needs within the Canadian Forces, but it may fail to meet the needs of special groups within the military. Combat arms troops, for example, clearly require a higher level of fitness than can be demonstrated in the CF EXPRES Programme and the individualized testing and programming associated with the CF EXPRES Plan may not satisfy the needs of units within the Army. Since individuals are expected to perform tasks demanding very high fitness levels within the context of a larger cohesive group.

PHYSICAL FITNESS AND THE CANADIAN ARMY

28. In a modern army, many demanding physical tasks that previously required muscle power are now being handled by machines (8). Vehicles and specialized equipment are used to move guns, ammunition and supplies, and instead of marching into battle, today's soldier most often rides in an armoured personnel carrier or helicopter. Nonetheless, there are still a great many jobs in the Army that demand a high level of physical fitness, in terms of strength and endurance. Today's soldier, like those in the past, must be prepared to fight anywhere in the world in all types of terrain and weather. And fitness to do just that encompasses the ability to perform difficult tasks under hazardous conditions and the ability to sustain a high degree of emotional strain without suffering psychological breakdown (18). In addition to carrying weapons and personal "kit", the soldier of today must also carry many additional pieces of equipment - such as NBC detection devices and protective equipment, radios, night vision devices - much of which did not exist 20 years ago. Trucks, armoured personnel carriers, tanks, and other heavy equipment used in the battle field may break down and require repairs that may involve heavy parts. Then too, equipment such as night vision goggles have made the 24 hour battle day a reality. Today's soldier must thus have the stamina to fight for longer periods of time without rest and sleep than in the past. Because of all these factors, the need for a physically fit soldier may be greater today than ever before.

29. The Canadian Forces (CF) defines fitness as "the physical ability and energy to accomplish assigned tasks, to meet unforeseen emergencies with vigour and alertness ... the ability to effectively withstand stress and persevere under difficult operational circumstances" (19). Or as an American study put it "physical fitness is a state of the body which permits a person to respond and adapt instantly and

efficiently to physical and/or emotional demands with a minimum of discomfort, and to return quickly to a normal and healthy state once the demand has been removed" (20). The study further emphasized that physical fitness, for the purpose of the Army, can be defined as those factors, which determine a soldier's ability to perform heavy physical work, and which contribute toward maintaining good health and appearance.

30. It has sometimes been argued that in today's highly mechanized military that fitness may not be as important as in the past. The Falkland experience of the British, however, supports the view that soldiers cannot depend on the availability or worthiness of transport equipment in operational theatres. In extremely inclement weather and over very difficult terrain, British soldiers were required to march as far as 60 km on foot carrying full combat loads of up to 60 kg and they were expected to arrive fit to fight on the same day. British commanders have described physical fitness and esprit de corps as their "secret weapon" in that conflict (21).

31. For the past three decades, physical fitness in the Army was thought to be characterized by factors such as low body fat, high relative oxygen consumption capacity, the ability to run fast for extended period of time, and the ability do a large number of push-ups, sit-ups, and chin-ups. It was thought that the individuals who met certain standards would be fit to perform their duties in the battle field. Experience in the Falklands, proved this concept to be false. There, soldiers who were lean and had a body build similar to that of typical marathon runners were least successful in carrying out their battlefield duties. Meeting "prescribed" standards in the noted performance factors(distance running, push-ups, sit-ups, etc), does not, therefore mean, that a soldier is necessarily fit to carry out the occupational requirements of army tasks in the field. In the opinion of the authors, the soldiers most capable of carrying out their combat duties in the Falklands were those who had mesomorphic (large muscle mass) type bodies, with high upper and lower body strength. Indeed, the consensus of opinion now appears to be that high levels of muscular strength and endurance are as important for soldiers as having the capacity for a high levels of oxygen consumption. Marching with external loads places far greater muscular strength and endurance demands on the body than marching with little or no equipment, and since this is a task every soldier must be capable of doing, it may be better overall measure of Army fitness requirements.

CANADIAN ARMY PHYSICAL FITNESS STANDARDS STUDY.

32. Significant progress has been indeed made by a Mobile Command Physical Fitness Standards Study completed in 1990. In this study, from the potentially hundreds of physical tasks which could have been chosen, a series of representative common tasks were selected by a committee of Army experts as being representative of the physical requirements of the Canadian soldier. The selection of these common tasks was based on a comprehensive review of the scientific and national and international military literature, interviews and field observations with subject matter experts in the field at Canadian Forces Base (CFB) Wainwright, and at Headquarters of 1 Canadian Brigade Group in Calgary, Alberta; and interviews and special meetings at Mobile Command Headquarters.

33. Accordingly, the following common tasks were selected for further study as to their suitability for inclusion in a task specific physical fitness evaluation regime:

a. execute survival duties of digging shellscrapes and trenches - scoop, lift, throw (a given amount) of standardized earth out of a shell scrape or trench (in a given time) using an issue shovel;

b. march (a given distance in a given time at a given pace) cross country in full fighting order in all weather and light conditions;

c. casualty evacuation - a soldier must lift another soldier (of approximately the same weight using the Fireman's Carry and evacuate that soldier (a given distance in a given time); and

d. handle material manually - lift a box equivalent in size/weight to a box of 5.66 mm ammunition unassisted to a level of a truck bed (a given height).

RESEARCH FINDINGS

34. The purpose of this study was to develop standards based on physical requirements of the job and physiological capacity of the soldiers. To achieve this a field and a laboratory test battery were administered to all soldiers. The field test battery consisted of:

a. casualty evacuation;

b. ammunition box lift;

c. maximal effort digging; and

d. weight load march.

35. These tasks represented the most difficult and representative common field tasks a soldier was expected to perform in the field. The laboratory test battery consisted of:

a. weight load treadmill march test;

b. wingate leg anaerobic power test;

c. wingate arm anaerobic power test;

d. muscular strength; and

e. muscular endurance.

36. The reliability coefficients of all tests included in the two test batteries ranged between 0.83 to 0.96. An expert panel of military judges was also utilized in the establishment of final standards. Statistical analysis of the data included Pearson Product Moment Correlations, Multiple Stepwise Correlations, Regression equations and Canonical Correlation. These were computed to determine overall relationship between the laboratory and field task variables. The final performance standards were based on:

a. pass - fail performance levels suggested by subject matter experts;

b. discriminant analysis of possible cut off performances in selected field tasks; and

c. soldiers physiological capabilities to meet job requirements.

RECOMMENDATIONS

37. The recommended physical performance standards were:

a. casualty evacuation in 60 seconds;

b. ammunition box lift in 300 seconds

c. maximal effort digging in 360 seconds; and

d. weight load march of 13 km in two hours and 26 minutes.

38. A physical fitness standard was established which measured aerobic and anaerobic capability, muscular strength and endurance, and related components of fitness. The work intensity for the several tasks to be included in the fitness test were identified through appropriate trials. Group data was gathered, and appropriate performance based on these criteria measures, was recommended. The result was the development of physical fitness performance standards for the Canadian Army that are task related (22).

SUMMARY

39. This in itself cannot, of course, be the final product since the purpose of this entire process was to improve overall levels of physical fitness so that all Canadian soldiers can more effectively carry out all of their demanding tasks, in peace, and, if need be, in conflict. Once these standards are in place then the physical educator will be able to provide training programmes and more effective feedback on the adequacy of current physical fitness training programmes. Work on these programs continues and will be reported in future papers.

40. In this paper, the authors have proposed a model to develop task related performance standards. An attempt has been made to discuss the purposes, physical abilities, and developmental phases of such standards. Applicability of related tests and models also has been discussed.

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