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## The Benefits of High Intensity Functional Training (HIFT) Fitness Programs for Military Personnel

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### Abstract

High intensity functional training (HIFT) programs are designed to address multiple fitness domains, potentially providing improved physical and mental readiness in a changing operational environment. Programs consistent with HIFT principals such as CrossFit, SEALFIT and the US Marine Corps' High Intensity Tactical Training (HITT) program are increasingly popular among military personnel. This article reviews the practical, health, body composition, and military fitness implications of HIFT exercise programs. We conclude that, given the unique benefits of HIFT, the military should consider evaluating whether these programs should be the standard for military fitness training.

### Keywords

military; high-intensity; functional; physical training; CrossFit

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In a recent survey of its worldwide membership, the American College of Sports Medicine (ACSM) found that high intensity exercise methods were the leading trend in the fitness industry<sup>1</sup>. Arguably the most popular exemplar of high intensity exercise programs is CrossFit, which describes its methodology as “constantly varied functional movements performed at relatively high intensity”<sup>2</sup>. The popularity of CrossFit is particularly noticeable among personnel in law enforcement, fire and rescue, and military units. For instance, there are currently over 250 registered CrossFit affiliate gyms on United States (US) military installations<sup>3</sup>. There is even a specially tailored version of CrossFit called SEALFIT, which was originally conceived to assist special operations candidates to successfully complete Navy SEAL training<sup>4</sup>. Participants in SEALFIT can test their readiness in “Kokoro Camp”, a three day event modeled after the US Navy SEAL Hell Week. As well, the US Marine Corps (USMC) developed an exercise program called “High Intensity Tactical Training”

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(HITT) which has many similarities to CrossFit<sup>5</sup>. HITT is described as “a comprehensive combat-specific strength and conditioning program that is essential to Marine’s physical development, combat readiness, and resiliency”<sup>6</sup>.

Exercise programs such as these can be grouped under the category *high intensity functional training* (HIFT). HIFT training programs are designed to address multiple fitness domains, potentially providing improved physical and mental readiness in a changing operational environment<sup>7</sup>. HIFT incorporates principles of high-intensity interval training (HIIT) in its programming, where relatively short bouts of high intensity exercise are used as an alternative to traditional aerobics training to promote metabolic conditioning<sup>8</sup>. HIFT workouts regularly integrate HIIT and functional training approaches, use principals from HIIT to structure intervals, and often use traditional HIIT workouts (such as Tabata interval sprints or rows) as part of their programming. In fact, in HIFT-based programs little distinction is made between HIIT and HIFT principals given there is no absolute separation in their influence on programming. Thus, henceforth in this review we will assume HIFT subsumes HIIT.

The principals of HIFT are consistent with a philosophy of military training called “Total Force Fitness” (TFF)<sup>7</sup>. A primary goal of TFF is to develop high levels of work capacity by targeting multiple components of fitness including strength, endurance, flexibility, and mobility<sup>9</sup>. HIFT training stresses both aerobic and anaerobic energy pathways<sup>9</sup> and is balanced in addressing power, strength, flexibility, speed, endurance, agility and coordination<sup>10</sup>. HIFT approaches emphasize functional movements (i.e., compound movements such as lifting, pushing, pulling, throwing and locomotion movements that familiarize the body with the operational environment) done at relatively high intensity that require universal motor-recruitment patterns in multiple movement planes<sup>10,11</sup>, making them useful in deployed environments where traditional fitness centers and equipment may not be available. The goal of HIFT is to produce high levels of cardiorespiratory fitness, endurance and strength that go beyond those achieved by following current physical activity recommendations<sup>12</sup>.

Given the investment in and popularity of HIFT in the military, it is important to consider the potential impact of this approach to fitness training for the health of military personnel and their risk of training injury. In a previous paper (Poston, et al) we addressed the question of whether HIFT was associated with higher rates of injury compared to other exercise programs. We argued that concerns about the injury potential of HIFT exercise programs were not supported by the scientific literature to date, although additional research was needed to directly compare injury rates in approaches such as CrossFit to traditional military fitness programs. In this article we will review the scientific data on the practical, health and fitness benefits of HIFT exercise programs for military populations.

## Practical Benefits of HIFT Exercise Programs

Table 1 lists several practical benefits of HIFT training which are important for military personnel. One particularly important practical benefit of HIFT is *decreased training time without reduction in health and fitness benefits*. HIFT training volumes are typically

between 25% to nearly 80% less than traditional military fitness programs such as Army Physical Readiness Training (APRT)<sup>13</sup> without reductions in fitness outcomes. For example, Westcott and colleagues<sup>14</sup> found that 75 minutes/week of HIFT circuit training resulted in improvements on all measures of the Air Force Fitness Test (i.e., pushups and abdominal crunches completed in 1-minute, 1.5 mile run time, waist circumference). In contrast, participants in a traditional military fitness training program showed no improvements despite logging 240–300 minutes/week of training time.

Heinrich et al.<sup>15</sup> found that a 45-minute HIFT per session program resulted in significant fitness improvements on the Army Physical Readiness Test (APFT) when compared to a standard 60-minute APRT per session program with active duty Army personnel, even though their total training time was 225 minutes less. Finally, Heinrich and colleagues<sup>16–18</sup> compared fitness outcomes for overweight participants in a CrossFit exercise group compared to a traditional American College of Sports Medicine (ACSM)-consistent fitness program. Despite the fact that training volumes were substantially lower (i.e., 38.7+15.6/week versus 190.0+10.7/week), participants in the CrossFit condition demonstrated more significant fitness improvements than those in the traditional exercise group.

HIFT programs are ideal for *incorporating activities and functional movements that simulate combat tasks*. Military commanders have recognized the need for Battle Focused Physical Training (BFPT), or programs that focus on tasks that would be expected in combat<sup>19</sup>. For instance, the United States Army Training and Doctrine Command (TRADOC) identified critical physical tasks required of soldiers including: lifting from the ground, lifting overhead, pushing, pulling/climbing, rotation, jumping and landing, lunging, marching, running, and changing direction<sup>20</sup>. Similarly, Batchelor<sup>19</sup>, conducted a survey of 349 U.S. Army Majors, 310 of whom were Operation Iraqi Freedom or Operation Enduring Freedom veterans, to identify the most important physical tasks involved in combat. The results were similar to the activities identified by TRADOC, namely: 1) move from one covered and concealed position to another; 2) lift a weight from the ground; 3) drag a casualty to safety; 4) conduct a “fireman’s” carry; 5) engage in continuous movement under combat load; and 6) climb over a wall. Unfortunately, Batchelor<sup>19</sup> noted that the Army’s currently physical fitness test failed to adequately assess a soldier’s ability to perform these basic combat tasks. An example of a fitness test based on BFPT is the Marine Corps Combat Fitness Test (CFT). The CFT has three parts: 1) an 880 yard sprint; 2) a 30 pound overhead ammunition can lift for 2 minutes; and 3) a 300 yard shuttle run which involves combat related tasks such as crawls, casualty drags and carries, ammunition resupply, grenade throwing, and agility running<sup>21</sup>.

To effectively accomplish combat tasks, military personnel need adequate levels of muscular strength, power, agility, coordination and stamina<sup>19,22–26</sup>. Standard military physical training programs and fitness tests for all services focus on cardio-respiratory fitness (e.g., the Army 4-mile unit run and the 2-mile and 1.5 mile runs that make up part of the APFT and the Air Force Fitness test, respectively) and muscular endurance (e.g., push-ups, pull-ups)<sup>27</sup>. Distance running, in particular, has long been a core training and assessment method for the military<sup>28</sup>. In contrast, HIFT programs are designed to produce general physical preparedness (GPP) across multiple fitness domains and general physical skills, including

specific tasks required for combat<sup>11,29,30</sup>. The importance of GPP to combat readiness was noted by the former Deputy Commandant for Combat Development and Integration for the Marine Corps, General James F. Amos, “The Marine athlete should be prepared for the physical challenges of combat with a program that develops both GPP and Specific Physical Preparedness – a program that integrates strength training based on functional, compound movements with multi-disciplinary speed, agility, and endurance training”<sup>10</sup>. HIFT fitness programs are specifically designed to promote GPP and to ensure that military personnel are physically prepared to face “unknown and unknowable events, a crucial capability in combat”<sup>11</sup>.

Effective HIFT programs can be conducted with *minimal or even no traditional exercise equipment*<sup>10,31</sup>. For example, the Canadian Infantry School tested a CrossFit-based fitness program called “Austere” which was designed to be conducted in austere environments where traditional exercise equipment would be unavailable<sup>31</sup>. The exercise “equipment” used in the Austere program consisted entirely of common military equipment (e.g., ammo cans) and readily available local resources (e.g., rocks and sand). One Austere workout involved four rounds for time (i.e., as fast as safely possible) of 50 squats with a 5.56mm ammo can (hugging the can) and a 600 meter run<sup>31</sup>. Other workout elements included bodyweight exercises such as sit-ups, push-ups, pull-ups, and burpees as well as strength/conditioning elements with objects like rocks, sandbags, and ammo cans (e.g., thrusters, presses, walking lunges, weighted pull-ups, etc.). Outcomes for the Austere program were equal to or better than the results of a control condition, despite utilizing significantly shorter workouts and no traditional gym equipment<sup>31</sup>.

*A key characteristic of HIFT exercise programs is constant variation*, which has been identified as an important element in combat-related fitness training. For instance, Amos<sup>10</sup> stressed the importance of variation in fitness training for Marines: “Combat poses an infinite variety of physical tasks, many of which are foreseeable, some of which are not. This varied nature of physical requirements and the fact that some aspects defy predictability, place any preparation effort that is overly specialized at risk of irrelevance.” The constant variation characteristic of HIFT programs also may lead to less boredom and more enjoyment and adherence to exercise. For example, Heinrich and colleagues compared a HIFT exercise program (CrossFit) with a traditional moderate-intensity aerobic and resistance training (ART) program in a randomized trial and found that the HIFT program had fewer dropouts and higher ratings of exercise enjoyment compared to the ART group<sup>16</sup>. Also, participants in the HIFT condition reported being more likely to continue their exercise program following the conclusion of the study compared to those in the ART group<sup>16</sup>.

HIFT programs typically do not include high volume endurance training. As a result, they result in fewer problems which are associated with the use of high volume endurance training (e.g., injury). Arguably the most recommended strategy for exercise related injury prevention is a reduction in training volume, particularly distance running training volume<sup>32–37</sup>. Despite the lack of traditional endurance training, HIFT programs have been demonstrated to result in levels of cardiovascular fitness similar to that found for long-distance endurance programs<sup>38</sup>. Thus, by reducing training volumes while also improving

fitness outcomes, HIFT promises to reduce the risks of injury associated with traditional military physical training while resulting in substantial gains in overall fitness.

*Equipment costs for HIFT exercise programs can be substantially less than equipment commonly found in military fitness centers.* For the cost of only one commercial-grade seated chest press machine (i.e., Torque Fitness M Series Commercial Chest Press)<sup>39</sup> and one leg/calf press machine (Body-Solid Pro Clubline Series II Leg Press and Calf Raise Machine)<sup>40</sup>, a military unit could purchase a package of equipment which would serve a larger number of troops and promote more functional fitness. For instance, the “Econ 5” military fitness package offered by Rogue Fitness® is priced less than the aforementioned resistance machines and consists of 1,000 pounds of bumper plates, Olympic lifting bars, 200 pounds of kettlebells, wood rings, a medicine ball, plyometric boxes, a Concept2® rower, squat stands, and a speed rope<sup>41</sup>.

Finally, HIFT programs can be scaled to all levels of fitness. Program design can be modified to reflect a military member’s physical abilities and to accommodate injuries. For instance, the USMC’s HITT program provides three levels of training, which range from *Athlete HITT* to *Warrior HITT*<sup>5</sup>. The *Athlete HITT* level is targeted to Marines who have adequate levels of fitness but who are not regular athletes while *Warrior HITT* is designed for personnel with high levels of fitness. Appropriate scaling is built into each of the three training levels. Similarly, the CrossFit community provides extensive information on appropriate scaling of workouts<sup>42</sup>. Thus, HIFT workouts are appropriate for military personnel of all fitness levels and athletic abilities.

## Health, Body Composition, and Fitness Benefits of HIFT Training

### General health benefits of HIFT programs

Table 2 outlines the health, body composition, and fitness benefits of HIFT programs. The general health benefits of HIFT programs include metabolic and physiological adaptations, such as changes in cardiac muscle cells, endothelial function, blood pressure, cardiac contractility, lipid oxidation, glucose and insulin levels, and skeletal muscle adaptations<sup>38,43–45</sup>. HIFT does not appear to limit speed, power or strength, or to promote systemic inflammation or oxidative damage like that experienced during traditional, sustained aerobic exercise<sup>46</sup>. Properly designed HIFT programs incorporate strategies recommended for injury prevention including a gradual systemic progression of training, balancing the body’s physiological training overload, and allowing for adequate recovery<sup>33</sup>.

### HIFT and Improvements in Body Composition

HIFT may be uniquely effective for reducing subcutaneous and trunk fat and waist circumference when compared to other exercise methods<sup>47</sup>. Because exercise intensity is proportionally related to post-exercise energy expenditure, post-exercise fat oxidation increases with exercise intensity<sup>48</sup>. The effects of high intensity training on body composition appear much more pronounced in longer studies, (e.g., those between 10–36 weeks) and with subjects who are overweight<sup>47,49</sup>. Tremblay and colleagues<sup>50</sup> found that participants assigned to HIFT lost substantially greater fat mass (measured waist

circumference (WC); -13.9 mm vs. -4.5 mm) when compared to those performing traditional endurance training over 15 weeks. This loss in fat mass was achieved despite significantly lower training volumes and lower training energy costs (57.9-megajoules vs. 120.4-megajoules for the endurance training).

A 12-week HIFT program conducted 3 times/week for 20 minutes per session in overweight males resulted in significant improvements in body composition. Those in the high intensity exercise condition significantly reduced their weight (-1.5 kg;  $p<0.001$ ) and fat mass (-2.0 kg;  $p<.005$ ), as compared to the control group who experienced no changes<sup>49</sup>. Trapp and colleagues<sup>51</sup> found that high intensity intervals led to greater decreases in weight (-1.5 kg) and fat mass (-2.5 kg) and increases in trunk muscle mass (+0.5 kg) in young women when compared to lower intensity training over 15 weeks. Finally, HIFT training 2-3 times per week resulted in reduced weight (-5.3 kg), BMI (-1.9 kg/m<sup>2</sup>), and WC (-5.8 cm) with no reported adverse events in overweight and obese adults over 36 weeks<sup>52</sup>.

Similarly, Walker et al.<sup>53</sup> found a 16.2% improvement in body composition (i.e., reduction in body fat percentage) after eight weeks of training among Combat Controller trainees using a HIFT approach. Smith and colleagues<sup>54</sup> also reported significant reductions in body fat percentage (i.e., absolute reduction of over four percentage points in men,  $p<0.001$ ; absolute reduction of over three percentage points in women,  $p<0.001$ ) and increased lean body mass (nearly 1kg increase in men,  $p=0.001$ ; over 1kg increase in women,  $p=0.01$ ) in their study following civilians participating in a CrossFit program.

One potential mechanism by which HIFT may positively impact body composition is through appetite regulation. For example, Sim and colleagues<sup>55</sup> examined the impact of a HIFT-based program on appetite regulation in 30 overweight, inactive men. Participants were randomized to either 12 weeks of high intensity intermittent exercise consistent with HIFT or moderate intensity continuous training (MICT). There was a clinically meaningful decrease in energy intake during a laboratory test meal for the HIFT group (516 + 395 kj) but no significant decrease for participants in the MICT condition. Participants in the HIFT condition also experienced significant improvements in insulin sensitivity. Thus, HIFT exercise programs may be uniquely effective in the promotion of appetite regulation.

HIFT programs also appear to be safe and effective for promoting fitness in those with unhealthy body composition. In the 8-week randomized trial by Heinrich and colleagues<sup>16,18</sup>, the CrossFit group significantly improved muscular endurance (situps +6.8%,  $p=0.01$  and pushups on knees +39.5%,  $p<0.05$ ) and VO<sub>2</sub>peak (+9.1%,  $p<0.05$ ), while the ACSM-standards comparison group only improved pushups done on knees (+24.4%,  $p=0.01$ ). The CrossFit group spent significantly less time training, averaging 13.1±0.9 minutes/workout and 38.7±15.6 minutes/week as compared to 63.3±6.3 minutes/workout and 190±10.7 minutes/week for the comparison group ( $p<.001$ ). In total, the CrossFit fitness intervention produced two to five times greater improvements on fitness outcomes after approximately one-fifth of the training time that would be expected in approaches such as that advocated by the ACSM or traditional APRT<sup>16,18</sup>. Thus, HIFT programming appears to be particularly effective for improving body composition and promoting fitness among overweight and obese individuals.



## Effectiveness of HIFT for Promoting Fitness in Military Personnel

Several studies have compared HIFT exercise programs to traditional physical training in military personnel on fitness outcomes. A non-randomized program evaluation of a HIFT-related fitness program using CrossFit versus usual training at the Royal Canadian Infantry School demonstrated that HIFT resulted in greater improvements in leg and core strength and cardiovascular endurance despite having less than half the running volume of traditional physical training<sup>56</sup>. Participants commented that the HIFT training was safer, increased group cohesion, had more combat-relevant exercises, was enjoyable, appropriate for groups, and was more challenging than their usual fitness program. Due to the fitness improvements, lower injuries rates, and greater adherence, the Canadian Infantry adopted a HIFT program called the “Combat Fitness Program”<sup>57</sup>.

Paine and colleagues<sup>11</sup> published a detailed study of the fitness improvements they assessed in a pilot study of 14 US Army officers. Participants underwent eight weeks of CrossFit, attending at least four, one-hour sessions per week. All participants demonstrated significant improvements on a variety of fitness metrics including a 20% overall increase in their work capacity, as measured by their power output on a number of standardized CrossFit workouts and the Army physical fitness test (APFT). They also increased their strength on standardized one-repetition maximum tests on the deadlift, strict press, and back squat. The authors noted that all participants experienced improvements regardless of initial fitness level and that while the training was focused on GPP, participants made gains in both strength and endurance<sup>11</sup>.

The Naval Health Research Center conducted a 12-week HIFT study comparing a new Combat Conditioning Trial Program (CCTP) with traditional Marine combat physical training in two US Marine Corps (USMC) battalions<sup>58</sup>. Development of the CCTP was prompted by the recent interest by the USMC in promoting functional fitness among Marines<sup>10</sup>. The program was designed to improve combat conditioning through the use of a wide range of varied activities performed at high intensity and using multi-planar and multi-joint movements including the following components: 1) core-specific strength (e.g., leg raises, planks, etc.); 2) bodyweight (e.g., pull-ups, rope climbs, pushups); 3) buddy (e.g., lifting and carrying a comrade); 4) locomotor exercises (e.g., bear crawls, crab walks); 5) strength training with field equipment (e.g., ammo can and sandbag lifts and carries); 6) agility and tactical sprints; and 7) functional barbell movements (e.g., squat, deadlifts, overhead presses).

The overall goals of the CCTP were to improve functional fitness and reduce injuries when compared to traditional USMC combat physical training using an approach that would be viable for use under field conditions and that would develop the full range of physical capabilities needed in combat<sup>58</sup>. At the end of the study period, both programs demonstrated equivalent performance on the USMC Physical Fitness Test and on measures of aerobic capacity, as measured in a variety of ways (e.g., 5k row and 1 mile run times). However, Marines in the CCTP group demonstrated superior core strength and power, agility, upper and lower body muscle endurance and power, and anaerobic capacity, while also experiencing significantly lower training and running volumes<sup>58</sup>.

Walker and colleagues<sup>53</sup> evaluated a HIFT fitness program with 119 US Air Force Combat Controller trainees over an eight week period. Combat Controller trainees participated in a revised physical training program that incorporated high intensity functional movement training and intervals that focused on power development and use of multi-joint exercises. At the end of eight weeks, investigators documented significant improvements in a number of physical performance measures including aerobic endurance, time to exhaustion, ventilatory threshold, upper body strength, and average peak power per kilogram of body weight. It was notable that the trainees experienced such significant improvements in endurance measures despite the fact that running volume was 50% less than the typical physical training<sup>53</sup>.

Heinrich et al.<sup>15</sup> completed an 8-week pilot trial intervention comparing a HIFT program called “Mission Essential Fitness” (MEF), a 45-minute high-intensity circuit-training program, to the Army’s physical readiness training (APRT) program. The study was conducted at Ft. Riley, Kansas with enlisted soldiers. MEF participants experienced significantly greater improvements in pushups (4.2 vs 1.3 pushups,  $p=0.033$ ), bench press strength (13.2 vs 2.7-lbs,  $p=0.001$ ), flexibility (0.6 vs -0.5-in,  $p=0.003$ ), and aerobic capacity, e.g., 2-mile run time (-83.9 vs -15.3 seconds,  $p=0.003$ ) and step test heart rate (-17 vs -9 beats,  $p=0.004$ ), when compared to APRT participants.

Similar to the outcomes found by Heinrich and colleagues<sup>15</sup>, data from a HIFT-related fitness program at Ft. Sill Oklahoma indicated that participation in CrossFit improved APFT scores by 13% over that by traditional APRT among Captains participating in the Air Defense Artillery Captains Career Course<sup>29</sup>. Smith and colleagues<sup>54</sup> also tested HIFT using CrossFit in a sample of 54 civilian men and women for 10 weeks of training. At the end of training period, both men and women experienced significant improvements in aerobic endurance and when initial fitness level was examined as a moderator of improvement, they reported that the improvements were significant regardless of initial fitness level<sup>54</sup>.

## Discussion

HIFT fitness programs address multiple fitness domains, potentially providing improved physical and mental readiness in a changing operational environment. These programs are increasingly popular among military personnel, as evidenced by the large number of CrossFit affiliates located on military installations. HIFT programs have clear practical benefits for the military community, including low cost of implementation, lower training volumes, and the ability to incorporate elements closely tied to physical skills often encountered in operational environments. In addition, HIFT programs provide a host of health benefits to military personnel, such as increases in both strength and cardiovascular endurance, improved body composition, and fitness outcomes often exceeding those found for traditional military physical training. Thus, we believe that fitness approaches consistent with HIFT principals should become the standard for military physical training.

Although the scientific literature on HIFT fitness programs is promising, there are unanswered questions about implementing these programs in the military context. First, no large scale randomized trials comparing traditional military physical training with HIFT



programs on both health and injury outcomes have been conducted. Such a trial could identify key elements from both types of programs which should be incorporated in future approaches to military fitness training. Our team is currently conducting a large randomized trial with the US Army comparing HIFT with ARPT training which should provide valuable data for identifying the strengths and weaknesses of both fitness models. Also, research regarding the optimal ways of implementing HIFT to maximize both GPP and combat oriented physical skills<sup>19</sup> is lacking. It is likely that a tailored approach to HIFT training which promotes GPP for all personnel along with specialized elements based on individual occupation demands would be maximally disseminable in the military.

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**Table 1**

## Practical Benefits of HIIT Training

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•	Shorter training times/volumes.
•	Incorporates activities and functional movements that simulate combat tasks.
•	Equipment needs are less, reducing costs, using less space.
•	Emphasizes constant variation in exercises and movements, intervals, equipment, etc. thus reducing the potential for boredom and adaptation.
•	Fewer problems which are associated with the use of high volume endurance training (e.g., injury).
•	Can be scaled to all levels of fitness, ability, and adapt to disability and rehabilitation needs.

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**Table 2****Health, Body Composition, and Fitness Benefits of HIFT Training**

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*General Health Benefits*

- Results in positive metabolic and physiological adaptations.
- Promotes both metabolic conditioning and muscular strength.
- Less systemic inflammation or oxidative damage compared to sustained aerobic activity.
- Lower volumes facilitate injury prevention.

*Benefits for Body Composition*

- Uniquely effective for reducing subcutaneous and trunk fat and waist circumference.
- Promotes appetite regulation.
- Effective for promoting fitness in overweight and obese individuals.

*Benefits for Military Fitness*

- Balanced approach to combat fitness including enhancing muscular strength, power, and speed.
  - Promotes general physical preparedness for the unknown and unknowable.
  - Equal or greater impact on the fitness of military personnel despite substantially reduced training volume.
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