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Obstacle Course Challenges: History, Popularity, Performance Demands, Effective Training, and Course Design

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ABSTRACT

Mullins NM. Obstacle Course Challenges: History, Popularity, Performance Demands, Effective Training, and Course Design. **JEPonline** 2012;15(2):100-128. The purpose of this article is to provide background information on the historical use of obstacle courses for physical conditioning, and to subsequently address the following questions, regarding modern obstacle course challenges: (1) What makes obstacle course challenges so popular? (2) What traits and abilities characterize top performers? (3) What should effective training entail? (4) What characterizes well-designed obstacle courses? The primary objectives are to comprehensively review the literature relevant to obstacle course training and competition, and to integrate established exercise-related science with practical information, to help others optimally prepare for obstacle course challenges.

Key Words: Adventure Racing, Interval training, Military Training

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INTRODUCTION AND HISTORY

The use of obstacle courses for enhancing, contesting, and assessing physical fitness, for sporting, military, and physical education purposes is ancient practice. Documentation of the use of obstacles in athletes' training regimes dates to at least as early as the Roman Empire, as can be seen in the following passage by Greek writer, Lucian (70):

> Furthermore, we train (young men) them to be good runners, habituating them to hold out for a long distance, and also making them light-footed for extreme speed in a short distance. And the running is not done on hard, resisting ground but in deep sand, where it is not easy to plant one's foot solidly or to get a purchase with it, since it slips from under one as the sand gives way beneath it. We also train them to jump a ditch, if need be, or any other obstacle, even carrying lead weights as large as they can grasp.

Lucian even explained the training-related utility of a popular element of many modern obstacle courses – mud (70). He acknowledged that the use of mud in training may at first seem "ludicrous," but noted that it helps cushion landings of individuals wrestling each other, and that it "gives much strength to their bodies," in making them work hard to grip and hold each other, when made slippery like "eels."

In some ancient societies, like Sparta, military training and education were essentially synonymous, as its citizens' sole purpose was to prepare for war (5). It has been said that, "Sparta did not have an army; it *was* an army," and that its children began their lifelong physical, military training at the age of seven. They engaged in a great diversity of activities, which constitute elements of modern day obstacle courses, including running, jumping, climbing, swimming, vaulting, balancing, and swinging from ropes.

Throughout modern history, obstacle courses requiring variable combinations of endurance, strength, agility, coordination, balance, and strategy have continued to be important in the physical training and testing of military personnel, as is documented scientifically, practically, and popularly. Scientifically, several research groups have examined factors affecting performance during military obstacle course negotiation (10,11,41,61,62,68,78). Practically, the training manuals for several armed forces discuss obstacle courses, from both physical preparation and leader implementation perspectives (30,31). The 432-page *Army Physical Readiness Training* manual, provided by the United States Department of the Army (31), dedicates a chapter to obstacle negotiation, stating:

> Obstacle course running develops physical capacities and fundamental skills and abilities that are important to Soldiers in combat operations. Soldiers must be able to crawl, creep, climb, walk, run, and jump in order to accomplish certain missions. They must be able to do all these things while carrying full field equipment for long periods of time without exhaustion or injury, even after fatigue has set in.

Documentation of obstacle course usage is also widespread in the popular media. Public information from the United States Marine Corps Recruiting Command (http://www.marines.com) cites the use of obstacle challenges throughout recruit training, including the demanding tests of both physical and mental fortitude provided by the confidence courses and "The Crucible." A recent search (3-16-12) for "obstacle course" on "The Official Homepage of the United States Army" (http://www.army.mil) yielded well over 500 news articles on the use of obstacle courses in the training of future soldiers. Countless other websites, newspapers and magazine articles, and television spots have also publicized obstacle course challenge events.

In addition to military uses, obstacles courses have long been used as valuable tools in physical education curricula (3,28,32,46,49). Not only can they be used to enhance motor development, but cognitive and emotional learning as well. Young children can learn movement terms and concepts, as they perform such skills as crawling, climbing, leaping, balancing, and ducking, "through", "on," "over," "inside," and "under" objects (46). Older students can learn basic anatomy and physiology, by identifying the muscles and joints most important to negotiating various obstacles, and by assessing changes in such parameters as heart rate, ventilation, sweating, and perceived exertion as they do so. Obstacle courses can also be used to develop skills related to orienteering, problem solving, constructing, leading groups, and working as a team, and to strengthen personal qualities, like courage, persistence, and confidence.

While obstacle course training and competition are not new, modern versions are soaring in popularity, among competitive athletes, fitness enthusiasts, and diverse others simply seeking a novel challenge. A mere partial list of popular obstacle challenge events, some of which may also be referred to as adventure races, fitness challenges, military combines, and mud runs, includes the Civilian Military Combine, Metro Dash, Muddy Buddy, Rebel Race, Ruckus Sports, Rugged Maniac, Rugged Warrior, Spartan Race, Tough Mudder, and Warrior Dash. These events vary considerably in the distances that they cover, in the number and difficulty of their component obstacles, and in the size and character of their competitive fields. Warrior Dashes (http://warriordash.com), for example, generally span 3.0 to 3.5 miles and consist of 12 to 14 obstacles, which most participants can negotiate successfully at some speed, and which highly athletic individuals can do so in minimal time. In contrast, Tough Mudder events (http://toughmudder.com/) typically cover 10 to 12 miles, include 20-30 obstacles, and have an average participant completion rate of only 78%. Note that the Tough Mudder is billed specifically as a "personal challenge" and not a race, with the primary goal being course completion. Obviously, exploring various events is important to choosing appropriate ones,

and then learning as much as possible about targeted events is essential to optimally training for them.

WHAT MAKES OBSTACLE COURSE CHALLENGES SO POPULAR?

What attracts so many participants to very vigorous, relatively risky obstacle challenge events, at a time when a majority of the population does not meet minimum recommendations for physical activity? Data indicate that only about 18% of American adults engage in the recommended minima for cardiovascular and muscular conditioning activities (18,101), yet obstacle challenges are drawing capacity fields of competitors, eager to endure grueling tests of aerobic and muscular fitness. Two of the most prominent theories of physical activity motivation, achievement goal theory and self-determination theory (SDT), may at least partly explain their appeal. Achievement goal theory holds that the primary motive for learning, striving, and persisting is the desire to demonstrate competence (82), and that individuals define success in this regard from two major perspectives (51,77). Task- or mastery-oriented individuals find success in working hard, learning, improving, and mastering skills, according to self-referenced criteria. Ego- or performance-oriented individuals generally see success as performing better than others, performing the same as others with less effort, or avoiding performing worse than others (i.e., other-referenced criteria) (51,77,82). Though the two perspectives are distinct, individuals can possess both task and ego orientations (51), which seems true of many obstacle race participants. Many assess their own performances, without relation to those of others; many judge their efforts solely according to finishing position; and some evaluate their exploits based on both meeting their own standards and performing well compared to others.

SDT maintains that all individuals have three major needs: 1) to act according to their own free will (autonomy); 2) to feel capable and effective in their actions (competence); and 3) to feel socially connected (relatedness) (19,27,66). According to SDT, intrinsic motivation, or motivation to participate in an activity because it is itself is pleasurable and rewarding (103), is enhanced when participation is voluntary and when it promotes competence and connection with others (19). Many obstacle challenge events seem to satisfy these needs. The large numbers of entrants in many of today's popular events seem to provide social connectedness for virtually everyone. The options to compete to win, to work for personal challenge, and to participate for fun, seem to provide autonomy and, for many, comfort, in enabling more and less competitive companions to participate in the same event, as it suits them. Certainly, motivation to participate could be undermined by pressure from significant others to participate, or by challenges that inspire feelings of incompetence, but the widespread popularity of obstacle events indicates that many participants' experiences are satisfying.

Intrinsic motivation may be multidimensional in nature, with desires to learn new things, to accomplish challenging tasks, and to experience stimulating sensations all serving as important catalysts for action (19,102,103). Direct observations and experiences support that many individuals feel gratification in learning to train and compete in new ways, in completing challenging obstacle courses, and in experiencing the exhilarating sensations associated with such tasks as running fast over rugged terrain, climbing over high barriers, traversing narrow platforms, and slogging through mud.

The desire to experience "varied, novel, complex, and intense sensations" has been linked to a personality trait referred to as "sensation-seeking" (117). Sensation-seeking has been associated with participation in high-risk sports (14,83,97) and, since there are considerable risks associated with obstacle course challenges, sensation-seeking could be a draw for some. It is, however, important to note that risk-taking and sensation-seeking are not synonymous (116,117). Sensation-seeking involves accepting risks as inherent to the process of pursuing rewarding sensations, but not seeking

risks for their own sake. Zuckerman (116) explained that sensation-seeking athletes strive to reduce risk through skill development, planning, and concentration, as is advocated for obstacle course training and racing. Csikszentmihalyi (25) suggested that risk is a significant contributor to challenge and that it is when athletes confront highly-challenging tasks, with highly-developed skills, that they are most likely to experience flow. Flow has been described as a state of consciousness characterized by complete, enjoyable absorption in an activity, with body and mind working synchronously to block out distractions and enable peak performance (25,58).

The mass media – a perennial force in driving consumer behavior, including that related to health and fitness (38) – is likely another important influence attracting participants to obstacle course challenges. Omniscient media delivery systems show people striving, succeeding, smiling, supporting others, and celebrating their obstacle challenge achievements, as well as report spirited accounts of their invigorating experiences. The Rebel Race (http://www.rebelrace.com/index.php) encourages freeing "yourself from the daily grind," while the Spartan race (http://www.spartanrace.com/) promises to provide the "adrenalin rush of your life." The Tough Mudder (http://toughmudder.com/) certifies that it will test, "strength, stamina, mental grit, and camaraderie," and that, "completing a Tough Mudder is a badge of honor." Ruckus (http://www.runruckus.com/ruckus-faq.html) claims to provide an "Adult Playground" experience, on an obstacle course, "demanding enough for the elite, but achievable for all." Despite the frequent use of words like "grueling" to characterize these races [a recent Rolling Stone write-up referred to obstacle challenges as "recreational suffering" (45)], the media framing is positive and alluring.

Finally, the popularity of obstacle course events may be fueled by the nature of their training, which can be exciting, can involve both peak aerobic and anaerobic exercise intensities, and can help minimize risks of overuse. The diversity of movement activities involved can help spark enthusiasm for conditioning, especially for those who find singular activities tedious, or for those whose more uniform training has become monotonous. As stated by Laursen (69), "When training does not have an appropriate blend of both high-intensity training and high-volume training inserted into the program, performance ability can stagnate." Since obstacle course conditioning is a form of interval training, it can enable individuals to perform more high-intensity work than is permissible by continuous training, and it can enhance both aerobic and anaerobic capacities (24,81). The movement diversity also distributes training stress over more muscles and joints, which may reduce risks of overuse injuries (6).

WHAT TRAITS AND ABILITIES CHARACTERIZE TOP PERFORMERS?

Diversified Skills and Capacities

Top obstacle course competitors tend to be individuals with diverse and well-developed motor skills and physical capacities. While obstacle courses vary greatly in the degrees to which they test different physical capacities and skills, they all challenge several. Those with longer running components, like the Tough Mudder, require considerable aerobic fitness, while those with less running and more numerous obstacles, like many military training courses (10,61), necessitate considerable strength, agility, balance, and coordination. A few research groups have attempted to characterize the physiological determinants of strong performance on military obstacle courses, and have confirmed the importance of aerobic and anaerobic power, muscular strength and endurance, body composition, and specific obstacle negotiation skills (10,11,41,61,62,68,78). Overall, findings support that strong performances result from complex combinations of skills and capacities, which vary according to specific courses. However, one recurrent finding of note is that of a significant negative relationship between body fat and performance, such that leaner individuals consistently complete courses faster (10,61,68).

Since obstacle course racing involves the speedy maneuverability of the body over, under, and through obstacles, skilled competitors have superior abilities to move their bodies with quickness, coordination, and efficiency. A high strength-to-weight ratio is advantageous, as it facilitates performance where speed, acceleration (52), and movement against gravity (108) are important. Since, as body size increases, body volume increases disproportionately to muscle cross-sectional area and therefore strength (52), larger athletes are disadvantaged in performing weight-supported movement tasks (11). This is true regardless of body composition, though large individuals with high muscularity will certainly have greater functionality than those with more adiposity (60,64). Relatively low body weights and lean body compositions facilitate efficient movement (15,26), and are characteristic of high-level distance runners (7), middle-distance runners (65), sprinters (96), hurdlers (56), jumpers (89,96), climbers (107,108), and gymnasts (7,37). However, while it is important to recognize that excess body fat may impair obstacle course performance (10.61,62,68), it is also important to avoid overemphasizing this point and inspiring unhealthy dieting and excessive training (13). Clearly, many factors contribute to strong obstacle course performance, including both health- and skill-related physical fitness, task-specific techniques (e.g., rope climbing, plank traversing, etc.), pacing abilities, nutrition, and motivation.

Adept Pacing

Wise pacing is widely recognized as important to performance, especially as events increase in duration, and strong obstacle course competitors appear to be adept at pacing. Pacing refers to the manner of distributing work or energy expenditure throughout an exercise task (1), to both optimize performance and to minimize large homeostatic disturbances (29,98,100). There are several major pacing strategies, which show some patterns of use according to event duration (1,47,99,100), but also considerable variability within events. Athletes may strive to maintain a consistent speed throughout an event (even pacing), may start relatively fast and then gradually slow down (positive pacing), may start slow and then gain speed (negative pacing), or may combine (parabolic pacing) or alter (variable pacing) strategies in accordance with external conditions (e.g., competitor surges, wind, elevation), sensory feedback, experience, and consideration of remaining work (1,29,69). Regardless of strategy, pacing appears to be skill which individuals can improve with training and competitive experience (47,111). Therefore, during training, it is important to develop strong awareness of exertion levels at certain paces. This awareness will serve individuals well during obstacle races, where objective performance feedback may be unavailable. Running split times may be considerably distorted by the negotiation of obstacles, and simply reading a watch may be difficult for a time after the negotiation of some obstacles (e.g., mud-filled pit). A keen awareness of exertion levels can help individuals stay on a pace for optimal performance, by preventing tendencies to chase ‘rabbits’ or to slow with suffering competitors.

Effective Self-Regulation

Successful performers are self-regulated learners, meaning that they exert control over their learning, including meticulously planning their performances (35,63,114). They constantly integrate knowledge of task demands, personal characteristics and abilities, potential difficulties, and previous learning experiences, for the express purpose of optimizing performance. Successful obstacle course competitors also exhibit strong self-regulation. They plan their sleep and travel schedules, nutrient intake and timing, apparel, warm-up routines, and race strategies. They stay apprised of weather and course conditions, as well as event rules and procedures. In contrast, there are large proportions of participants at many of today’s popular obstacle events that evidence poor planning and a failure to exert control over performance. Many rely on onsite food and beverage for nutrition, which may be neither conducive to good performance, nor consistent with usual eating. Many dress inappropriately, wearing, for example, large, loose t-shirts that become hindrances of their own after negotiating water

obstacles. Many approach starting lines without clear performance objectives or race strategies, and without having warmed up in ways that will ease the transition from rest to intense activity. Inordinate numbers simply stand at starting lines. In sum, those seeking peak obstacle course performances should plan well and leave as little as possible to chance.

A special aspect of planning positive obstacle challenge experiences concerns taking steps to minimize risks of infection. Many of today's popular events are contested in unsanitary outdoor environments, made more so by thousands of participants traversing the same course in a single day. The risk of infection is real and is acknowledged in many participant waivers (e.g., http://toughmudder.com/waiver/; and http://warriordash.com/documents/WD_2011_Participant_Waiver.pdf). Common risk factors for many types of viral, bacterial, and fungal infections include direct and indirect personal contact, swimming in water containing microbial, animal, human, or chemical contaminants, skin abrasions and lacerations, and food and beverage contamination (8,53,67,76,86,112), all of which may exist at obstacle course events. Individuals should therefore strive to minimize risks, by taking the following precautions: ensure an updated immunization status, minimize person-to-person contact, cover all existing wounds with occlusive dressings, promptly clean any wounds incurred during the event, avoid ingesting food and water handled carelessly in crowded areas, and maintain as high a level of personal hygiene as possible (e.g., avoid remaining in dirty clothing for extended periods, avoid walking barefoot on unsanitary grounds, etc.) (8,53,67,76).

WHAT SHOULD EFFECTIVE TRAINING ENTAIL?

Course Knowledge

The great variability in obstacle course design and in the skills and abilities required to negotiate various courses makes it inappropriate to make definitive recommendations for training programs. Obstacle course challenges may vary tremendously between different types of events and even between the same types of events, run in different locations, at different times. Individuals should characterize the demands of targeted events as clearly as possible, and then tailor their training as specifically as possible to those demands. Key characteristics include the total distance to be covered, the types and numbers of obstacles to be included, the distances between obstacles, the nature of the local terrain, the local climate, and the potential number of participants on the course at any given time. Considerable information can generally be gained through event organizers' websites and other forms of social media, though sometimes events do include 'mystery' or 'secret' obstacles. Obstacle courses used for training military personnel, police cadets, and firefighters are often outlined on websites and in training manuals. The website of the Royal Canadian Mounted Police (www.rcmp-grc.gc.ca), for example, specifies that its cadets must complete six laps of a 350-m course, involving hurdling, stair-climbing, vaulting, and controlled falling.

Training in Accordance with Course Knowledge

As is often the case, understanding that a specifically-designed training program must address the metabolic, biomechanical, and psychological demands of a sport or activity (43) is very different from implementing one that adeptly does so. Exercise professionals know that many individuals train with movement types, intensities, and durations that are not consistent with their targeted events or competitions, sometimes under conditions very dissimilar to what will be actual conditions. Judicious training for an event covering 10 miles and including 25 obstacles will clearly differ greatly from that for a 3-mile race with 15 obstacles, and even more from that for a 400-m race with 20 obstacles. Course length and composition will dictate the relative contributions of aerobic and anaerobic metabolism, and also determine demands for neuromuscular coordination. Having to perform 20 different skills in rapid succession will pose a different challenge to "coordinative abilities" (33), than

performing them several minutes apart, especially in terms of movement adequacy (i.e., choosing appropriate movements), synchronization (i.e., coordinating body movements), spatial orientation, balance, and reaction to signals. During obstacle course challenges, there is frequent need to react efficiently to such stimuli as physical contact with competitors, obstacle shifts with human movement (e.g., cargo nets and planks can shake as multiple bodies climb or traverse them, drag forces can fluctuate with currents, eddies, wind, and competitor movements, mud can spread over larger areas, etc.), and changing weather and course conditions (e.g., rain can alter footing, impair grip, and reduce visibility).

Specific training should also involve consideration of event location and time. As indicated earlier, even obstacle challenges operated by the same event organizers, may vary considerably with location, due to features of the local terrain. Purposive training for an obstacle race to be run in a mountainous region should emphasize hill running, while swimming, wading, and hurdling work may be wise emphases for one to be held in flat area, with abundant water. With respect to event time, individuals should consider the temporal aspects of training specificity. Several studies have shown that exercise performance at a particular time of day may be meaningfully affected by regular training at the same time of day (21,55,94,97). Therefore, individuals training for large obstacle challenge events, with wave starts spread over a large portion of the day, should either register for start times that match their usual training times, or begin to train at times that match their registration.

Interval Training

Since obstacle course negotiation involves interval work, interval training should be predominant within the overall training program. Interval training, or the performance of “repeated bouts of high- to moderate-intensity exercise interspersed with rest or reduced-intensity exercise” (110), provides a means of completing larger volumes of intense work than can be accomplished if the work is carried out continuously. The relief periods forestall fatigue by facilitating restoration of the phosphagens and clearance of lactic acid (40). Designing a challenge-specific interval training program involves first determining the energetic demands of the challenge, and then planning work and relief activities consistent with those demands, including their intensities, durations, repetitions per session, and weekly frequency (40,110). In obstacle challenge events, negotiation of the obstacles will constitute the work activities, and locomotion between obstacles, the relief. While the relief periods in some forms of interval training may involve very light activity, like walking, in obstacle racing it will involve running. However, even high-intensity running can afford relief, as long as it is below the lactate threshold. In fact, peak blood lactate clearance occurs at intensities just below the lactate threshold, where lactate production is low, and blood flow and lactate oxidation are high (74,80).

As an example, consider a 5-kilometer course, with 14 obstacles spaced every 300 to 400 m. Consider that most of the obstacles will take a particular individual less than 30 secs to complete (e.g., using a rope to scale a 4-m high wall, crawling through a 10-m long tunnel, traversing a 15-rung set of monkey bars, running across a six-meter long plank, etc.), while a few will likely take between 1 and 2 min (e.g., climbing a steep 400-m long hill, swimming shod across a 20-m long pond, etc.). The time required to complete the entire race will place heavy demands on the aerobic system, while the durations and intensities of obstacle-related movements will stress the phosphagen and glycolytic systems. Assuming all-out efforts, obstacles requiring only 5 to 10 secs to negotiate will rely heavily on the phosphagens, while those extending beyond 10 secs up to about 2 min will also stress the glycolytic system (80). Strong preparation for such a race will involve overloading all three of the energy systems, with proportional emphases, as well as addressing any skill-related deficits (e.g., climbing, traversing rungs, swimming, etc.). Ideally, training should involve negotiating obstacles as similar as possible to those of the targeted event.

When it is not feasible to train with actual obstacles, protocols used for high-intensity interval training (HIT) can provide a means of stimulating metabolic adaptations in all three energy systems. HIT or SIT (if the work bouts consist of sprinting) involves brief, repeated bouts of maximal exercise, separated by periods of rest or lower-intensity exercise, and has been shown to significantly improve both aerobic and anaerobic performance (17,44,54,71,79,113). While both work and relief intervals may range from a few seconds to a few minutes, protocols involving work bouts of 30 secs and recovery periods of 4 min are common (1:8 work:recovery ratio) (16,17,44,54,71,79). Such protocols may or may not approximate the energetic demands of particular obstacle challenge event and ratios should be tailored appropriately. For the individual striving to complete the hypothetical 5-km/14-obstacle race in 22 min, a 1:3 ratio would be more suitable. Dividing the race into 14 segments makes each about 1:34 in duration. Assuming that the individual will encounter obstacles approximately every 90 secs, most of which will take less than 30 secs to negotiate, work:recovery ratios of 30-sec:90-sec, or 1:3, better match the competitive task. It would, however, be wise to incorporate a few shorter and longer work bouts to simulate the expected variation in the obstacles.

Of course, the hypothetical example outlines the basis for only one workout, in what must be a comprehensive program for optimizing performance, perpetuating motivation, and avoiding overtraining. Effective training should involve day-to-day variation in activities, intensities, and durations, as well as periodization strategies to promote long-term effectiveness (12,22,57,106). These strategies are manifold and beyond the scope of this paper, but one should recognize that periodization is a “process of planning” optimal training and that it “is not a rigid one with only one form of approach” (91). Many methods support the ultimate objectives of keeping training stimuli effective and exciting, minimizing risks of overtraining, and achieving performance goals.

Since high-intensity interval training may increase signs and symptoms of overtraining (9,92), vigilance is important as interval sessions are added to training. Billat et al. (9), for example, reported that middle distance runners, initially training with continuous, lower-intensity running protocols six days per week, showed performance improvements as two continuous sessions were replaced by one interval and one threshold session. Further intensification, however, to replace another continuous, with another interval session stimulated no additional improvements and increased several markers of overtraining. Reviews of the training characteristics of elite endurance athletes support the efficacy of distributing training intensity such that 75-80% of weekly sessions involve high-volume (lower-intensity) work, and 20-25% high-intensity (lower-volume) efforts (69,87,88). Data indicates that, for athletes training 10 to 14 times per week, two to three HIT sessions per week seem well-suited to stimulating physiological adaptations, while avoiding excessive stress and allowing maintenance of a strong aerobic base (87). Again, recognize the essentiality of training specificity, as these ratios may provide sound guidance for events within the aerobic range, but may be entirely inappropriate to guide training for short, anaerobic obstacle races. Specific proportions aside, HIT training is recommended as a central element of obstacle course training, keeping in mind that, as for all methods, too much can yield diminished returns.

Resistance Training

With respect to resistance training for obstacle course racing, it is most important for individuals to optimize their strength-to-weight ratios. Individuals with underdeveloped abilities to efficiently maneuver their own body mass will struggle through such tasks as climbing walls, crawling through tunnels, swinging on ropes, and vaulting over barriers. While a variety of resistance training modalities are useful and advocated, individuals should ensure strong competencies in performing body weight exercises, like pull-ups, push-ups, dips, curl-ups, hanging knee raises, burpees, box jumps, and jump squats and lunges. Body weight exercises can enhance mobility, coordination, and

kinesthetic awareness, and many can be performed anywhere. This favors their incorporation into obstacle course workouts, especially for those with limited access to facilities and equipment.

"Random" and "Variable" Training

Motor learning research has helped elucidate how the distribution of practice tasks within a training session can affect learning and performance (72,84,85). Some of the findings can be applied to obstacle course training, with four terms of particular relevance. The first two distinguish ways of practicing several different skills within a single session, as in training to negotiate several different types of obstacles (e.g., climbing a cargo net, traversing a plank, vaulting over a low wall, etc.). The second two identify means of practicing different versions of the same skill within a single session, as in training to improve climbing abilities, using different techniques, obstacles, and conditions.

- blocked practice = spending substantial time rehearsing one skill, before moving on to another (e.g., practicing hurdling for 20 min, followed by balance training for 20 min, followed by climbing 20 min)
- random practice = rotating continually amongst skills being rehearsed (e.g., practicing hurdling, balancing, and climbing, at random, for 60 min)
- constant practice = rehearsing the same version of the same skill (e.g., repeatedly climbing the same wall, in the same way)
- varied practice = rehearsing different versions of the same skill (e.g., climbing different obstacles, such as a wall, a cargo net, an overhanging ladder, etc.) , or rehearsing the same skill under differing conditions (e.g., climbing a wall without vs. with a loaded pack, climbing a cargo net singly vs. alongside others, etc.)

While all four types of practice have advantages, random and varied schedules appear to promote better learning and retention among individuals having reached the motor stage of learning (85), which will be the case for most people negotiating most obstacles. In the immediate sense, individuals engaged in blocked practice may perform better than those in random practice, as they correct and refine a given skill under the prevailing and therefore relatively predictable conditions (e.g., traversing a plank, independently, un-fatigued, wearing dry shoes). Blocked practice is important during initial learning, to ensure that individuals are capable of reproducing a skill, and it appears to generate confidence, as individuals focusing fully on one skill at a time often make rapid progress. However, at later times, when conditions differ from those of the practice period (e.g., traversing a plank, while highly fatigued, accompanied by competitors, wearing wet shoes), individuals who have engaged in only blocked practice may greatly underperform. In contrast, individuals who utilize random practice schedules often show poor initial performance, but superior learning during delayed performance testing, when skill retention becomes essential (72,84,85). Practicing under inconsistent conditions seems to enhance abilities to reproduce skills at different times, in different settings, under different circumstances. Research suggests that random practice enhances learning by forcing performers to recall and recreate appropriate patterns of movements, rather than simply ingraining one. In the context of obstacle negotiation, an individual using a blocked schedule to practice traversing a set of monkey bars is more likely to rehearse a specific pattern of hand placements than an individual moving from another obstacle to the monkey bars. Since various factors during a race could interfere with an individual's ability to execute the identical blocked practice patterns, random practice seems important. While blocked practice and its relatively predictable conditions, "deny learners the opportunity to learn what they don't know," random practice can enhance abilities to generalize learning (59). Since learners may experience less immediate success during random versus blocked practice, they may enjoy it less (59,85), making it important to remember that, "…people learn by making and correcting mistakes" (59). Making mistakes, actively

processing them, and adjusting techniques and strategies to eliminate or minimize them, help create more elaborate and meaningful memories, which enhance learning and future performance.

The advantages of variable over constant practice are similar to those of random over blocked schedules. Constant practice provides better immediate results and response automaticity, under the specific conditions of the training session, while varied practice enhances abilities to produce appropriate responses to changing contexts (72,84,85). Varied practice promotes generalizability of learning, by helping individuals develop sets of rules for successful movement (schemas). As they are challenged by task variations, they learn to appropriately adjust skill parameters for successful performance (e.g., speed, height, distance, force, etc.). This adaptability, in turn, favors successful future performances. Since obstacle course racing involves the execution of a diversity of tasks, under constantly varying conditions, sometimes with unknown parameters, the importance of both random and variable practice schedules seems obvious. Random practice can enhance the abilities to recall and recreate the motor patterns needed to negotiate a variety of different obstacles, while variable practice can expand individuals' repertoire of rule sets for guiding movements under unpredictable conditions (72,84,85). Blocked practice may be appropriate for those learning new skills, but once competency is attained, obstacle course training should involve continual rotation amongst skills and frequent alteration of the parameters associated with those skills. As an example, for the following segment of an obstacle course workout, option B is recommended over option A. Option B is consistent with research supporting the superiority of practice conditions that allow individuals to experience numerous variations of their tasks each day (72). In doing so, they can create more elaborate memories of their movements and of the types of adjustments that will favor skillful performance, under the changing and perhaps unknown conditions in an obstacle course race.

Option A:

- 3 x (run 250 m → traverse a 15-runged set of monkey bars)
- 3 x (run 250 m → climb up and over a 20-foot cargo net wall)
- 3 x (run 250 m → hurdle 10 low barriers, spaced 3 meters apart)

  = 2250 m + 9 obstacles

Option B:

- 1 x (run 300 m → traverse a 15-runged set of monkey bars, lead with right hand)
- 1 x (run 200 m → climb up and over a 20-foot cargo net wall)
- 1 x (run 200 m → hurdle 10 low barriers, spaced 3 m apart, lead with right foot)
- 1 x [run 250 m → (traverse a 15-runged set of monkey bars, lead with left hand)
- 1 x (run 300 m → hurdle 10 low barriers, spaced 3 m apart, lead with left foot)
- 1 x (run 300 m → climb up and over a 20-foot cargo net wall)
- 1 x (run 250 m → hurdle 10 low barriers, spaced 3 m apart)
- 1 x (run 250 m → climb up and over a 20-foot cargo net wall)
- 1 x (run 200 m → traverse a 15-rungs of monkey bars, 7 forwards and 8 backwards

  = 2250 m + 9 obstacles

Dynamic Balance and Grip Training

With respect to task-specific techniques, dynamic balance and grip warrant attention. Many obstacle courses have at least one balance segment that involves running or walking fast across a narrow plank of some sort, making it wise to incorporate dynamic balance activities into training circuits. One can create elaborate, zigzagging planking systems, or simply make use of a long board, log, or curb. Those engaging in balance training should have a fundamental understanding of strategies for maintaining balance, including widening the base of support (which may not be an option), lowering

the center of gravity, counterbalancing limbs moving outside the base of support (50), and focusing on stationary versus moving objects (46). They should also know, as gymnasts are taught, to direct the visual focus towards the end of the 'balance beam' rather than directly downwards, as looking down can disrupt posture and balance by shifting the head – a heavy body part – in front of the center of mass. Balance training can be progressed in a number of ways, including narrowing the 'beam,' encouraging faster travel across the segment, or requiring skills other than walking or running across the expanse, such as hopping, turning, or bear crawling.

Many obstacles involve tasks that require considerable grip strength and endurance, as in gripping ropes, rungs, wall edges, and even earth, during steep hill climbs. Useful training strategies include traversing monkey bars, simply hanging from bars, ropes, rings, or hangboards, particularly by one arm at a time, and performing farmer's carries with challenging loads, over varying differences. Various types of balls, putties, and mechanical devices for squeezing can also be used to enhance hand and forearm strength and endurance.

Sex- and Age-Related Considerations

Since females tend to have less upper body strength than males (36), female competitors should place special emphasis on training to negotiate obstacles that will heavily tax the upper body. Males, in contrast, may benefit from emphases on flexibility and balance, since any deficits in these areas could impair the negotiation of some obstacles. Although not conclusive, some evidence indicates that males have less flexibility (4,93) and dynamic balance (48,109) than females.

Since strength (36,95), flexibility (93,95), and dynamic balance (95,104) all decline with advancing age, masters athletes may need to reprioritize their training to address common age-related deficiencies. For example, many athletic older adults participate more regularly in endurance exercise than in resistance training (39,95), despite a real need for resistance training.

WHAT CHARACTERIZES WELL-DESIGNED OBSTACLE COURSES?

As for training, it is difficult to make specific recommendations for the design of obstacle courses, due to the varying purposes that they serve (e.g., competition, physical conditioning, confidence building). Thus, the following recommendations are based largely on professional judgment, experience, safety considerations, and common sense.

- While some obstacles, or parts of obstacles, are inherently unstable and unpredictable (e.g., muddy slope, oscillating cargo net, etc.), elements that are built should be solidly constructed. Both the Department of the Army (31) and the Department of the Air Force (30) provide useful safety standards and guidelines for constructing, maintaining, and operating obstacle courses, which readers are encouraged to examine.

- Course organizers should scrutinize the final course for as many potential hazards and foreseeable risks as possible. While risks cannot be eliminated, steps can often be taken to control and minimize hazards. Obstacles should be inspected for structural integrity and for their potential to cause laceration, puncture, and abrasion. Scaffolding should be inspected for sharp projections (nails, splinters, etc.), ropes for fraying and rotting, pipes for corrosion, landing areas for adequate cushioning material (e.g., shredded rubber, mulch, hay, etc.), and terrain for extraneous hazards, such as tree branches at eye level, sharp stumps, and insect nests. Substantial hazards that cannot be removed should be clearly marked.

- To optimize performance and safety, obstacles should be arranged so as to shift the physical demands amongst muscle groups, avoiding similar emphases in consecutive obstacles.

- To minimize the risk of falls and fatigue-related injuries, the last few obstacles should neither be the highest, nor the most difficult (31).

- Military authorities (30,31) specify that soldiers should be given clear instruction on how to negotiate each training obstacle and be granted opportunities to practice doing so. Since participants in obstacle course races generally will not have such opportunities, they should learn as much as possible about courses, beforehand, and train accordingly.

Obstacle and Interval Descriptions and Ideas for Implementation

While many 'fun' names can be assigned to obstacles and exercises, it is important to retain a working vocabulary of fundamental movements. While most people have a general understanding of movement terms, producing precise definitions can be more difficult. Thus, provided along with the following obstacle and interval training ideas are a few important definitions to which to anchor training activities. Table 1 and Figure 1, together, and Table 2 and Figure 6, provide sample circuits that can be set up indoors and at a park or playground, respectively, and that can be used for both individual and group training (place one individual at each station).

Table 1. Sample Indoor Interval-Obstacle Circuit *

EXERCISES **		
1.	T	Burpees (push-up, broad jump variation)
2	T	Medicine ball high tosses
3.	C	Scooters (see **Figure 2**)
4.	L	Jump-split lunges
5.	U	Rope waves
6.	T	High table vaults, with 6-m cone run
7.	U/C	"T" push-ups
8.	L	Traveling "unders" (move forward and laterally under rope, plastic tape, or similar barrier; see **Figure 3**)
9.	C/U	Stability ball, prone, knee-to-chest tucks
10.	L	Box jumps
11.	T	Farmers' carry, around cones 10-12 m apart
12.	L	Speed switches (on low plyo box; see **Figure 4**)
13.	T	Elevated cartwheels (place hands on block or stacked mats; see **Figure 5**)
14.	T	Prone mountain climbers
15.	U	Pull-ups/chin-ups, on wall bar (attach resistance band for those needing assistance)
16.	L/C	Balance beam runs (or 180° turns, down the length)
17.	T	Sled push (use power sled, or toy sled, filled with weights or cement blocks, on carpet surface)
18.	T	Bear crawls and reverse bear crawls (forward and back, over designated distance; e,g, 10 m)
19.	L	Hurdles over low barrier, with 4-m cone runs (alternate lead hurdling foot, each time)
20.	T	3-point hip extensions (on stability ball, or inverted BOSU Ball)

*See **Figure 1** **Dominant targets: T = total body, U = upper body, L = Lower body, C = core

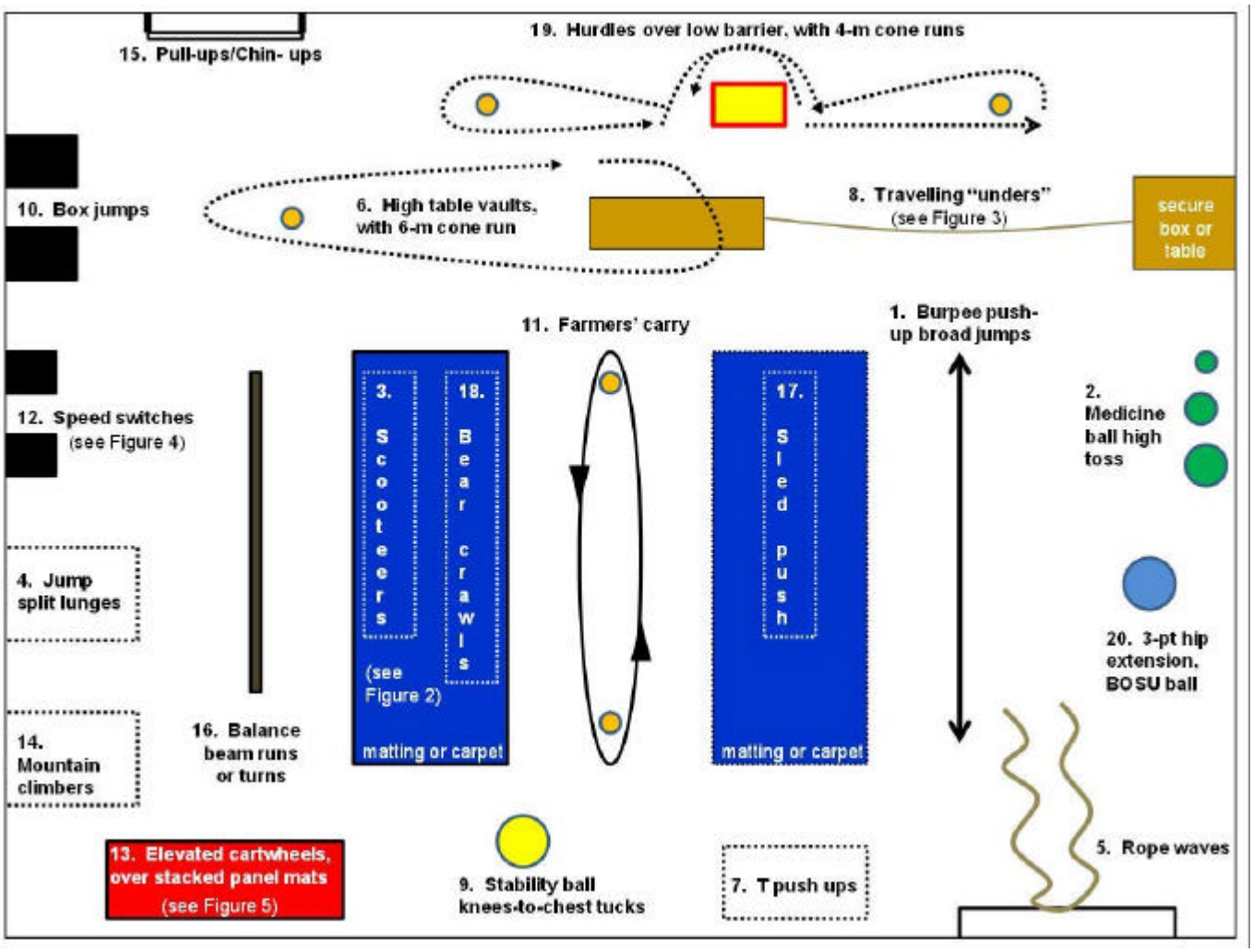

Figure 1. Indoor Interval-Obstacle Circuit. Use with Table 1.

Figure 2. Scooters.

Figure 3. Travelling "unders."

Figure 4. Speed switches.

Figure 5. Elevated cartwheels.

Table 2. Sample Park/Playground Interval-Obstacle Circuit *

EXERCISES **		
1.	L	Picnic table “up-and-overs” (see **Figure 7**)
2	U	Monkey bar traverses (see **Figure 8A**)
3.	L	Traveling “unders” or “over-unders” (move forward and laterally under, or under and over, a parking barrier, rope, or similar object; see **Figure 3**)
4.	T	Elevated cartwheels (hands on bench; see **Figure 5**)
5.	L	Bench/barrier jumps (see **Figure 9**)
6.	T/C	Pullovers or leg/knee raises on par course bar (see **Figure 10**)
7.	L	Speed switches (on low curb, rock, or step; see **Figure 4**)
8.	U	Swing set chain or pole climb (see **Figure 8B**)
9.	T	Park bench, post, or fence vaults
10.	L	Agility weave, between trees, bushes, or poles
11.	U	Pull-ups/chin-ups, on par course bar, monkey bars, swing set, or low tree branch
12.	L	Low hurdles over boulders, curbs, or similar barriers
13.	T	Playground slide climb
14.	L/C	Playground balance beam or log runs (see **Figure 8C**)
15.	L	Stair climb

*See **Figure 6** **Dominant targets: T = total body, U = upper body, L = Lower body, C = core

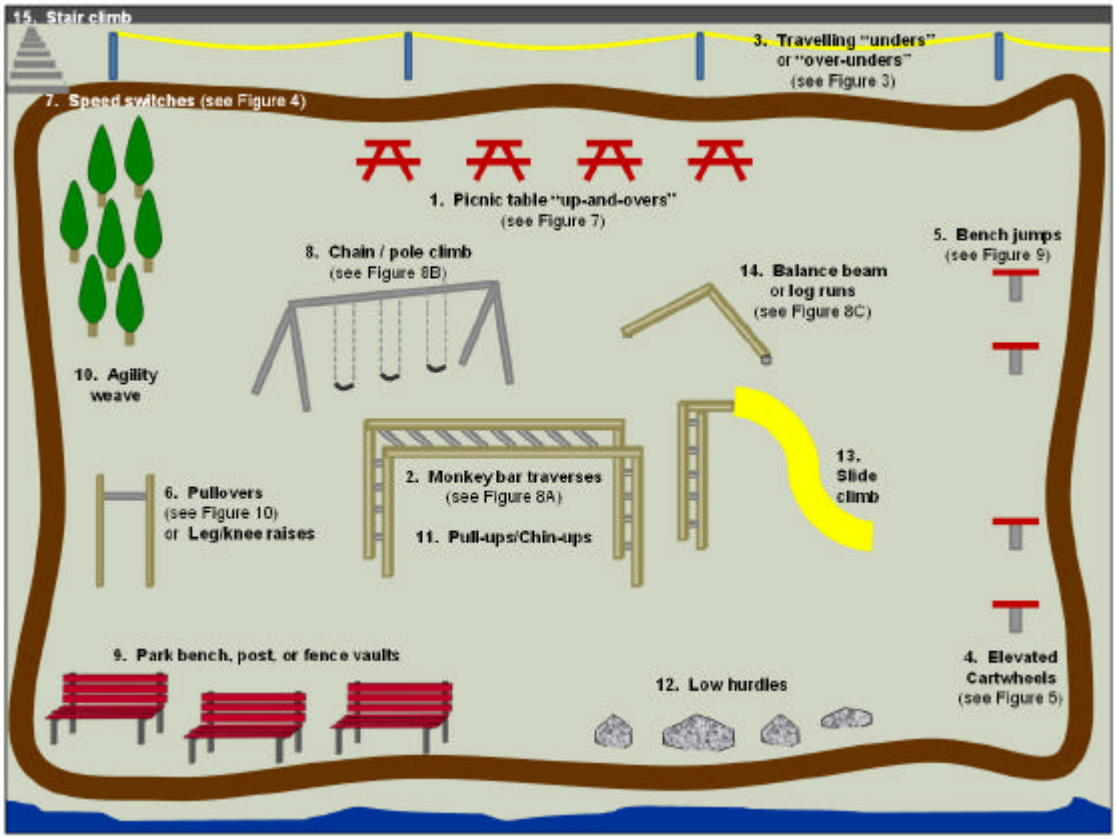

Figure 6. Park/Playground Interval-Obstacle Circuit.

Figure 7. Picnic table "up-and-overs."

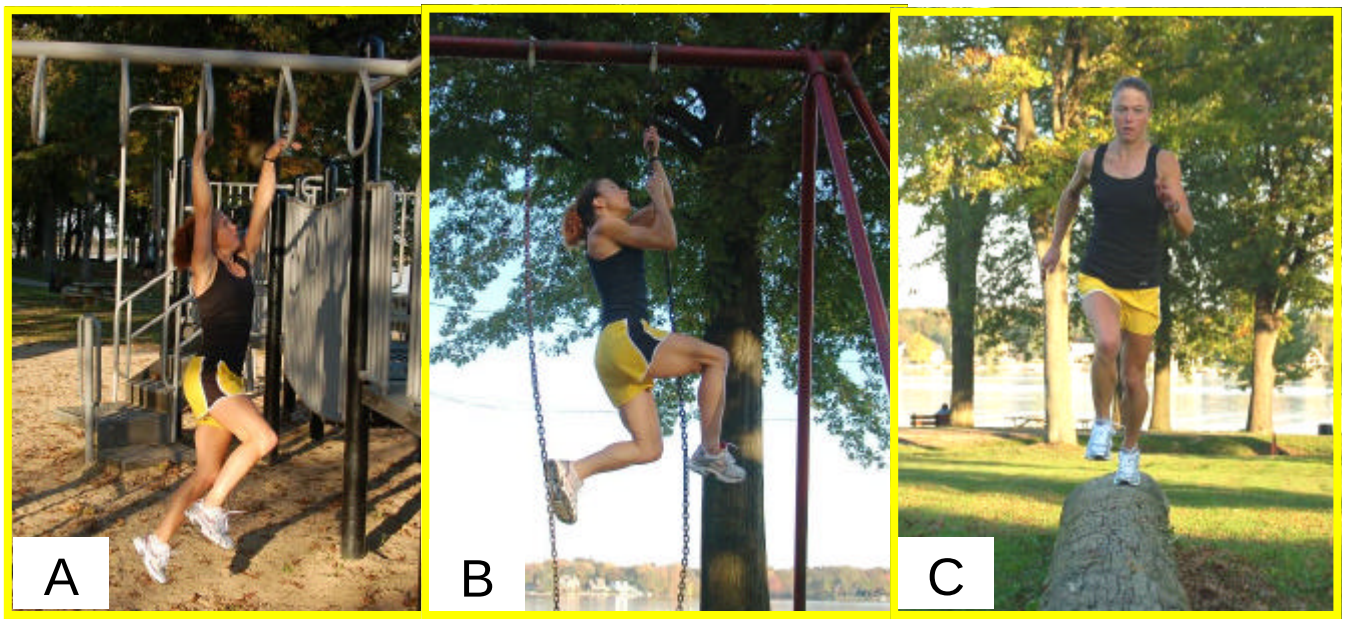

Figure 8. A) Monkey bar traverses. B) Swing set chain or pole climb. C) Playground balance beam or log runs.

Balancing: maintaining a stable position (46)

- Static: maintaining a stable position, while stationary (e.g., handstand)
- Dynamic: maintaining a stable position, while initiating movement, moving, or stopping movement
- Ideas: Incorporate balance beams, 2"x4" boards (on the ground or atop supports), logs (see Figure 8C), narrow benches (e.g., stadium bleachers), sawhorses, slacklines, taped or chalked lines (straight, zig-zag, curved) into obstacle circuits.

Carrying:

- While the definition and necessity of carrying are obvious, its importance to military and public safety personnel cannot be overstated. Firefighters, paramedics, and military personnel all need to be able to efficiently carry equipment, supplies, and sometimes people, and certainly all people can benefit from improved abilities to carry objects, whether for job-related purposes (e.g., nursing, construction, etc.) or activities of daily living. It is noteworthy that McGill (73) has advocated exercises like the farmers' walk and bottoms-up kettlebell carry for building athleticism

in a more “spine friendly” way than constant barbell squatting. Such exercises help develop strong core stabilization capabilities, while focusing power training on the hips and legs.

- Ideas: Incorporate ‘farmers’ walk’ intervals that involve carrying barbells, dumbbells, plate weights, sandbags, buckets or other heavy objects over prescribed distances.
- Safety: As objects being carried become heavier, more muscle force is needed to stabilize the torso and to counter compressive forces on the spine. Heavier objects also require more energy to move, which can accelerate muscular fatigue and increase tendencies towards poor lifting technique (e.g., inappropriate twisting of the spine, inadequate use of the legs in raising and lowering objects from the ground. Thus, it is important that adherence to sound technique take precedence over the use of heavier weights.

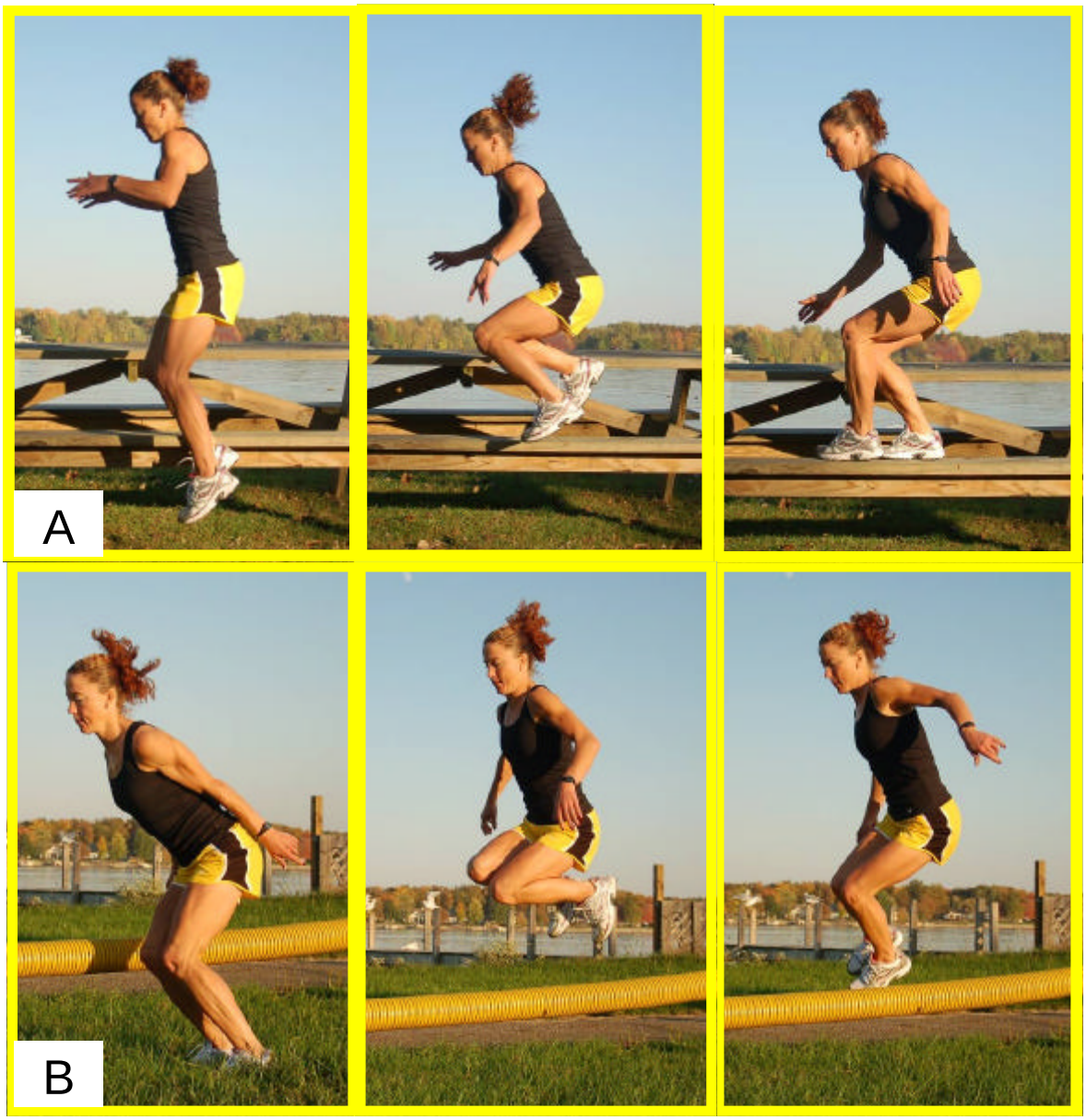

Figure 9. A) Bench jumps. B) Barrier jumps.

Figure 10. Pullovers.

Climbing: ascending, using hand and footholds (20)

- Ideas: If available, incorporate cargo nets, walls, poles, ladders, ropes, and chains (see Figure 8B) for climbing into obstacle training. Commercial climbing systems provide excellent tools, but are expensive. Where fewer resources are available, a simple rope secured to wall, ceiling, or tree can provide the means for climbing, with the options of down-climbing or jumping down. Climbing steep grades, especially with slippery surfaces (e.g., wet or muddy) can also require the use of both hands and feet.
- Safety: Landing surfaces should be covered with some sort of cushioning material (commercial matting, rubber shreds, hay, etc.).

Crawling: moving forward on the hands and knees, or creeping along the ground (20)

- Many obstacle courses incorporate some type of tunnel through which participants must crawl, which may create anxiety for those with claustrophobic tendencies. Thus, it may be wise, not only to practice the act of crawling, but to do so within some sort of actual enclosure, particularly a dark one. In some cases, the mental training may be more important than the physical training.
- Ideas: Manufactured hurdles, rope, string, plastic tape, or natural structures, such as low tree branches, can be used to demarcate areas for crawling at various levels, ranging from movement on the hands and knees, to abdominal drags using the elbows. Concrete form tubes (e.g., 48" x 12') provide excellent tunnel structures, as do hoop-supported garden low tunnels. Numerous gardening centers, collegiate horticulture programs, and websites can provide instruction on how to construct low tunnels, using wire or PVC pipe and polyethlene covers. Simplistic tunnels can be created by covering a series of sawhorses, benches, or utility tables with tarp.

Dodging: moving the body quickly in a direction other than the original movement (46)

- Ideas: Arrange commercial agility poles, cones, or flexible rods (e.g., driveway markers) to create slalom-like courses to navigate. Hang tires or other objects from ropes and stable structures to create moving obstacles to dodge. Another form of dodging, frequently incorporated into obstacle course races, involves alternating between climbing over an obstacle and then ducking under another. Such series of obstacles can be made simply with hurdles of various sizes, or even with rope or plastic tape strung at different heights.

Dragging: pulling or hauling along, especially with effort (20)

- Firefighters may especially benefit from the incorporation of dragging tasks into obstacle training courses, as job tasks may entail dragging hoses and other equipment to fight fires, as well as dragging people to safety from fires (2)
- Ideas: Drag any heavy object several meters (e.g., 15-20), turn around and return to the starting location. Pulling a rope attached to a commercial sled or tire works well, as well a snow sled filled with heavy material, such as weights, bricks, or sandbags. Snow sleds work well on grass, carpet, and felt-covered matting.

Jumping: locomotor pattern of propelling the body off the ground from one or two feet, travelling straight upwards or over a distance, maintaining a momentary period of flight, and landing on one or both feet (42,46)

- At least three forms of jumps have specific names:
  - Hopping: action of springing from one foot, in any direction, and landing on the same foot
  - Leaping: action of springing from one foot and landing on the opposite foot, usually with considerable leg extension and oppositional arm movements; essentially an extension of running, with a longer flight phase and most often performed singly rather than in a repeated pattern
  - Hurdling: same action as leaping, but over a hurdle, or barrier
- Ideas: Jump over, or on and down from, picnic tables, narrow benches, boulders, logs, plyometric boxes, platforms, milk crates (filled, to support the body weight), or other available objects (see Figure 7). Jump over commercial hurdles, plyometric boxes, cones, parking barriers (see Figure 9), hay bales, folded mats, step benches, or rope, twine, or plastic tape, strung at various heights.
- Vary the direction of jumping (e.g., forward-back, side-to-side, straight up), or use tires, hula hoops, or carpet squares to create jump sequences of varying distances and patterns.
- Vary the type and intensity of jumping. A circuit with a series of cones, like that above could require two-foot jumping over them during one lap, and leaping over them during a second lap (one or more than one at a time). A circuit could involve a set of jumps over a box (lateral or forward-back) during one lap, and single leg push-offs during a second lap (i.e., With one foot on top of the object and the other on the ground, jump as high as possible and land with the other foot on top the object and the other on the ground, either on the same side or different side of the object).
- Safety: To minimize risks of overuse injuries, this author recommends keeping the cumulative number of foot contacts during the jumping intervals of a workout lower than the upper ranges recommended for plyometric training (105). The rationale is that the lower body will sustain considerable stress as the high-intensity forces of jumping (especially hopping) are added to the lower-intensity, but high-volume forces of running. Moreover, proper plyometric training requires adequate recovery between exercises, which will not take place during the high-intensity intervals of obstacle course training.

Rolling: action of transferring weight between body parts, around a central axis (46)

- Proficiency in basic gymnastics skills is useful for obstacle course training. The incorporation of an interval of repeated rolls or cartwheels within a circuit can help challenge and train equilibrium.

During races, rolls can be used as a means to cross or descend cargo nets, and as a safety maneuver when losing balance or dropping from heights.

- Ideas: Using a series of 3-4 barriers, repeatedly combine jumping, landing, rolling, and running (e.g., climb or leap upon a barrier, jump down, roll, and run to the next barrier). Also combine repeated rolling with another movement, over a specified distance (e.g., forward roll, long jump, repeat). For very difficult challenges to both strength and balance, well-suited to indoor circuits, perform the following sequence: forward roll to stand on one leg, hop, forward roll to stand on the opposite leg, hop.
- Safety: Sound technique, especially for rolls, is extremely important for injury prevention. Most importantly, the hands and arms must support the body weight as the back of the head and upper back contact the ground, and the back must be rounded to ensure a smooth, non-jarring movement. Obviously, grassy or well-matted areas are best for rolling sequences. Avoid placing balance challenges immediately after sequences that involve rolls or cartwheels, as temporary dizziness could compromise perceptions and unnecessarily raise risks of injury.

Scooting: sliding, especially while seated (75)

- Ideas: Sit on the ground, with the hips flexed, knees close to the chest, and feet held off the ground. Place hands on the ground, as far forward as they will reach, without touching the feet to the ground, and use the arms to 'scoot' the buttocks forward several inches, somewhat like an ape or gorilla walks. Repeat 15-20 times, then get up and run to the next obstacle (see Figure 2).

Skipping: combined action of a step and a hop on one foot, followed by a step and a hop on the other foot, usually in a repeated sequence, with arms and legs working in opposition (46)

- Skipping for height or distance (power skipping) can help improve explosive power and dynamic flexibility, through aggressive work on triple extension, or extension of the ankle, knee, and hip (34).

Vaulting: projecting one's body into the air, using the hands or a pole as a lever, often over a barrier (20)

- Ideas: Train vaulting skills by incorporating barriers like low walls, tables, railings, fences, park benches, and sawhorses into circuits.

Wading: walking through some depth of water, mud, snow or sand (20)

- Ideas: While impractical and imprudent to include often, due to the erosive and shock-reducing effects of wetting footwear (23), it can be useful to occasionally incorporate a segment of knee deep water running (e.g., 150 m), early in a circuit, to provide the experience of having to complete a course with wet, heavy shoes.

CONCLUSIONS

Obstacle course training is a highly effective means of training multiple fitness components and of developing diversified skills and abilities. It offers variety from traditional endurance and resistance training, and, because many exercises can be accomplished using only the body weight and some creativity with the environment, it can be an inexpensive means of conditioning. The diversity of challenges imposed by obstacle courses, both physical and psychological, promote the development of self-discipline, perseverance, courage, resourcefulness, and both self-reliance and teamwork, depending on the situation. Obstacle training teaches individuals to ambitiously attack adverse

conditions and to reap the rewards of overcoming them. As wisely expressed by an African proverb, “Smooth seas do not make skillful sailors" (115).

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