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REVIEW ARTICLE

Masters sprinters: Less is more

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ABSTRACT

Masters athletes have been considered a paradigm of successful aging, which research has shown that many of the age-associated physiological changes are more related to external factors to aging itself, such as sedentary lifestyle and deconditioning. Sprint training always poses a challenge, even more in such demanding athletes as masters sprinters, given that age mainly affects those physical capabilities that are most determinant of sprint performance, such as speed, strength, flexibility, and coordination. The main purpose of this paper was to comprehensively review masters sprinters training, emphasizing certain aspects that are especially relevant in these athletes, such as training principles, specific resistance training, recovery strategies, and invisible training.
Keywords: Sprint performance; Athletic training; Resistance training; Recovery training; Masters athlete.

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INTRODUCTION

Maximum speed is determined not so much by moving the limbs fast as by exerting force against the ground and minimum ground contact time. Therefore, sprint training should be oriented to the development of maximum power in the large muscle groups through sprint, strength and jump work.

Masters athletes are individuals over the age of 35 who follow high-level physical training programs and participate in competitions designed specifically for them. These athletes have been a model for studying the aging process and the effects of physical training on aging and have been proposed as examples of successful aging. This research has shown that many of the physiological changes associated with aging are actually attributable to factors extrinsic to aging itself, such as sedentary lifestyle and deconditioning (Geard et al., 2017; Tanaka, 2017).

The main objective of this narrative review was to review the sprint training in such a demanding athlete as the masters athlete. First, a brief commentary was made on the physiological changes associated with age that can condition performance and the appearance of injuries in the masters athlete. Subsequently, the most relevant aspects of sprint training adapted to the masters athlete were reviewed. The bibliographic search was carried out between January 2002 and December 2022, in the following search engines and databases: Google, PubMed, Embase and Cochrane Library. The search terms used were: sprint performance; athletic training; resistance training; warm-up; recovery; nutrition; masters athlete; aging.

MASTERS SPRINTER PHYSIOLOGY

Energy systems

The predominant energy system in sprinting is the anaerobic system. Within this we differentiate two systems according to the metabolic contribution: the alactic system, which provides energy from the phosphagen accumulated in the muscle cell (ATP and phosphocreatine) and has a very limited duration, between 5 and 15 seconds; and the lactic system, which provides energy from anaerobic glycolysis from 15-20 seconds and up to 45-90 seconds. Sprint training will induce enzymatic adaptations mainly in these energy systems although, to a lesser extent, it will also induce them in the aerobic system (which provides energy from aerobic glycolysis from 90 seconds).

Age-associated changes in the anaerobic system include reduced muscle levels of substrates and enzymes involved in alactic metabolism (phosphocreatine and creatine kinase) and lactic metabolism (glycogen and lactate dehydrogenase); and decreased peak blood concentrations of the main end product of anaerobic metabolism (blood lactate) and its main buffer to counteract the resulting acidosis (bicarbonate) (Reaburn & Dascombe, 2009).

Endocrine system

Age is associated with changes in hormone secretion and feedback patterns. From the third decade on, there is a generalized decrease in hormone levels, and among them, anabolic hormones—insulin, testosterone, somatotropin (GH) and somatomedin (IGF-1)—which play a fundamental role in tissue repair and adaptation to training (van den Beld et al., 2018).

Cardiovascular system

The main changes in the cardiovascular system associated with age are mostly related to the aerobic system and are the following: decrease in maximum heart rate (1 beat per year from the age of 10 years), due to the loss of cells in the cardiac conduction system and lower response to circulating catecholamines; and decrease in maximum oxygen consumption (10% per decade from the age of 25 years) due to lower muscular oxygen extraction, due to the progressive loss of muscle mass (Cheitling, 2003).

Nervous system
Dynapenia is the generalized loss of muscle strength and power associated with age (7-8% per decade from the age of 30) and is due to the changes it produces in the motor unit or complex formed by a motor neuron and the set of muscle fibres it innervates.

Within the nervous system, there is a reduction in the number, size and firing of alpha motor neurons; and a decrease in nerve transmission at the neuromuscular junction or motor plate due to denervation (without regeneration) of the motor plate (Tanaka et al., 2019).

Musculoskeletal system
At the muscular level, sarcopenia or progressive loss of muscle mass occurs from the age of 40 at a rate of 0.5-1% per year. Although it affects type I (slow twitch) and type II (fast twitch) muscle fibres, it seems to be more marked in type II fibres. Therefore, the loss of speed (0.09 m/s per year) is more evident than the loss of endurance (0.06 m/s per year). There is another phenomenon associated with age, which is sarcostenia or intrinsic weakening of the muscle and which is due to the decrease in contractile proteins (actin and myosin) and fatty infiltration of the muscle.

At the bone level, osteoporosis or progressive loss of bone mass occurs in men from the age of 50 at a rate of 0.4% per year and in women from the age of 30 at a rate of 0.75-1% per year (tripling after menopause) and may be related to pathological or stress fractures. It is worth noting the close communication between bone and muscle in such a way that they share control mechanisms and, therefore, changes in bone or muscle mass are regulated by the same factors.

At the joint level, age is associated with a decrease in collagen production which affects tendons and joints, leading to a progressive decrease in flexibility and range of joint motion. Likewise, age is associated with a decrease in the production of mucopolysaccharides which favours the accumulation of water in the cartilages and weakens them, leading to a progressive loss of cartilage and may be related to different degrees of degenerative joint disease or osteoarthritis (Tanaka et al., 2019; Wright & Perricelli, 2008).

TRAINING PRINCIPLES

Overload
Progressive increase in training load—volume and intensity—along with adequate recovery periods are associated with neuromuscular and metabolic adaptations, and with improvements in performance (supercompensation) in the long term. It also reduces the risk of injury, maladaptations and decreased performance (overtraining) associated with rapid, excessive or insufficiently recovered overloads (typical of changing periods within a season).

Specificity
Neuromuscular and metabolic adaptations are specific to the stimulus applied, so training must take into account the pattern and intensity of the movements, and the energy systems and muscle groups involved. Therefore, sprint training must be fundamentally high intensity and high power, including both running and strength work of the muscle groups involved in sprinting.

Individualization

All sprint training should be programmed based on the individual characteristics of the athlete: age, anthropometry, training level, recovery capacity and strength-speed profile. In order to prevent injury and improve performance, the masters sprinter must reduce the total volume of training, increase recovery periods between sessions and microcycles, and prioritize strength work.

Periodization

Periodization is the systematic and structured planning and variation of training in order to reach one or two performance peaks, coinciding with the main competitions of the year. Periodization is divided into work cycles, which can be of three types: Macrocycles (1-2 quarters), which coincide with the indoor or outdoor track seasons; Mesocycles (1-2 months), which focus on specific objectives (capacity or power, mainly alactic and lactic) depending on the time of the season (pre-season, pre-competition or competition); Microcycles (1-4 weeks), which include weekly work sessions (running or strength), alternating loading and recovery weeks (generally in a 2:1 or 3:1 ratio). In general, there are two types of sprint periodization: Downward, in which the beginning of the macrocycle is focused on the long sprint (speed endurance) and the end on the short sprint (acceleration and power), being typical of 200-400 meters sprinters; Upward, in which the beginning of the macrocycle is focused on the short sprint and the end on the long sprint, being typical of 60-100 meters sprinters (Kasper, 2019; Haugen et al., 2019).

SPRINT TRAINING

Based on the principle of specificity there are three types of sprint training methods: Primary methods, which are specific workouts that simulate the sprint movement pattern, such as running technique drills (bounces, jumps, bounds or hurdles) and the sprints themselves (different distances, intensities and rests); Secondary methods, which are equally specific workouts that reproduce the sprint action but with resistance (sled, parachute, weighted vest or uphill) or assistance (elastic cord, motor device or downhill); Tertiary methods, which are less specific workouts that develop capacities useful in sprinting, such as strength work (free weights or weight machines), plyometrics (horizontal or vertical jumps) and stretching (static, dynamic or ballistic).

More specifically, sprint training sessions must be programmed based on the desired capacity or phase of the 100-meter sprint to be worked on: acceleration (first third), maximum speed (second third) and deceleration or speed endurance (last third) (Haugen et al., 2019).

Acceleration

The acceleration phase in the 100-meter sprint comprises the first 30-40 meters, the energy system involved is the alactic anaerobic system and the ground reaction forces (GRF) will have a predominance of horizontal forces. In the masters sprinter there is a decrease in the acceleration capacity at a rate of 1% per year as a consequence of dynapenia and a reduction in effectiveness when applying the GRF (especially the horizontal forces), which is why their work is a primary objective of the training (Pantoja et al., 2019; Haugen et al, 2019).

The recommended work are 20 to 40-meter distances on hard surface (track), 100% intensity, starting blocks or three-point start, full recovery (1 minute for every 10 meters) and a total volume of 100-300 meters. From a technical point of view, the focus should be on executing the triple extension (hip-knee-ankle) with the trunk inclined at 45º, performing very powerful anterior-posterior supports and with longer contact time with the ground (especially during the first 4 steps) (Haugen et al, 2019).

Similarly, resisted sprint work (overload) is recommended over the same distance, surface, intensity and rest as free sprinting, but with half the volume (so that a transfer to free sprints can be performed immediately afterwards). The resistance applied must not alter the movement pattern or running technique (especially stride length), so the recommended sled/vest load is 10-20% of body weight, parachute surface 1.2 x 1.2 meters and uphill incline 10-20% (Haugen et al, 2019; Alcaraz et al., 2018; Leyva et al., 2017).

Maximum speed

The maximum speed phase in the 100 meters comprises the second 40-50 meters, the predominant energy system is also the alactic anaerobic and the GRF will have a predominance of vertical forces (Pantoja et al., 2019; Haugen et al, 2019).

The recommended work are 20 to 30-meter distances with a running start (acceleration distance 10-20 meters), 100% intensity, full recovery (1 minute for every 10 meters including acceleration distance) and a total volume of 50-200 meters (without including acceleration distance). Technically, the focus should be on keeping the hips high and performing very fast up-down supports with minimal ground contact time (Haugen et al, 2019).

Likewise, assisted sprint work (superspeed) is recommended over a distance of 20 meters with a running start, 105% intensity, full recovery (1 minute for every 10 meters including the acceleration distance) and a volume of 60-100 meters. The assistance applied must optimize the movement pattern or running technique, by decreasing ground contact time and increasing stride length and stride frequency (especially the latter), with the recommended load on the elastic cord being 5-30% of body weight, 40-50 N on the motor device and the downhill incline 5-10% (Haugen et al, 2019; Leyva et al., 2017).

Speed endurance

The deceleration phase or speed endurance in the 100 meters includes the last 20-30 meters, the GRF will also have a predominance of vertical forces and the predominant energy system is also alactic anaerobic but with the participation of lactic anaerobic (Pantoja et al., 2019; Haugen et al, 2019).

In this section it is important to differentiate two concepts and their forms of training: Anaerobic power or lactate resistance, which measures the maximum peak energy that can be generated in 90 seconds (mainly between 15 and 45 seconds). It improves performance in the last third of the 100 meters and, above all, in the second half of the 200 and 400 meters. The recommended work are 80 to 300-meter distances, intensity 95-100 %, full recovery (1 minute for every second of sprinting) and a total volume of 300-1000 meters; Anaerobic capacity or lactate tolerance, which measures the total amount of energy available that can be maintained in 90 seconds (mainly between 45 and 90). This is the basis on which to develop anaerobic power and allows repeating series or sprint races at maximum intensity during work sessions or competitions, so it is essential during the preseason and early season. The recommended work are 100 to 500-meter distances, intensity 80-95%, incomplete recovery of 1-6 minutes (maximum lactate level that allows performing the next series at the same intensity), and a total volume of 600-2000 meters. From a technical standpoint, in both types of work the focus should be, in addition to the technical considerations of the maximum speed phase, on maintaining a relaxed body posture and facial expression (ideally in all phases), and a wide arm swing ("*hands to the face*") (Haugen et al, 2019).

RESISTANCE TRAINING

Most of the scientific research on aging and sport points to resistance training as the most critical or important factor in maintaining maximal capacity for both physiological aging and sport performance. Moreover, considering the importance of strength work in sprinting, it becomes a fundamental pillar of any training program for the masters sprinter and should occupy a predominant role as the aging process progresses (Fragala et al., 2019).

Resistance training must be periodized throughout the season according to the objectives of each cycle, whether they are the morphological muscle adaptations (hypertrophy) of strength work and specific to the beginning of the season, or the neuromuscular functional adaptations (coordination and recruitment) of power work and specific to the end of the season.

More specifically, training sessions must be programmed based on the type of strength to be worked: maximal strength, explosive strength, reactive strength and preventive strength. Regardless of the type of work, it seems that strength training based on speed of execution produces better adaptations with a lower total volume of work (and therefore less risk of injury) than that based on percentage of maximum repetition or 1RM (100% of maximum load that can be moved in a single repetition) (Suchomel et al., 2018; Hartmann et al., 2015; Coratella et al., 2022).

Maximal strength

Although maximal strength training does not have a specific transfer to sprinting, it is the foundation on which two other types of strength are built—explosive and reactive—which are more specific to sprinting and is critical during the preseason and early season. The goal is to move loads ≥80% of 1 RM. Maximum strength work produces improvements mainly in muscle hypertrophy (increase in the transverse diameter of muscle fibres), intramuscular coordination (recruitment of muscle fibres) and intermuscular coordination (predominant action of agonist and synergist muscles over antagonists within muscle groups), but also on neuromuscular function (recruitment of motor neurons and motor units). Likewise, maximal strength work presents greater performance on the horizontal force vector and, therefore, greater transfer to the acceleration phase of the sprint (Suchomel et al., 2018; Hartmann et al., 2015; Coratella et al., 2022; Loturco et al., 2018).

Multi-joint exercises with free weights (Olympic bar or dumbbells) are recommended, highlighting squats with all their variants (back, front, Bulgarian, pin, and overhead), deadlift and hip thrust for the lower limb; and bench press, military press, rowing-bar and pull-up for the upper limb. The recommended work are sets of 4-8 RM (80-90%), 2-3 minutes recovery and a total volume of 3-5 sets. Technically, the focus should be on keeping all joints aligned and performing a slow eccentric phase and a fast concentric phase. Deterioration of technique and moderate loss of execution speed (up to a maximum of 25%) are very useful indicators for programming recoveries and the total volume of work sessions, as well as for considering their end when they appear (Suchomel et al., 2018; Hartmann et al., 2015; Coratella et al., 2022; Loturco et al., 2018; Hickmott et al., 2021; Held et al., 2022; Dorrell et al., 2020).

Within the maximum strength work, the star exercise for sprinting is the back squat. It is especially important for the acceleration phase where the horizontal GRFs that depend on the leg extensors (gluteus maximus and quadriceps) predominate. There is a clear correlation between maximal strength (1 RM) in squat and performance improvement (3%) in 30-meter sprint. A point of controversy is the range of motion (ROM) used and the benefit it can provide: full or deep squats (120-140º) produce an overall improvement in maximal strength and greater specific activation of the gluteus maximus, but present greater technical difficulty (joint alignment and sticking point) and greater joint work (especially the knees); Partial squats—half squat (90º) and quarter squat (45º)—work a similar joint movement pattern to the sprint (especially the quarter squat), produce greater improvement in that specific ROM, allow supramaximal loads (105-110% of 1 RM of the deep squat) and present less technical difficulty and joint distress (important in the masters sprinter), but produce less gluteus maximus activation. Therefore, both types of squats should ideally be combined throughout the season, with deep squats prevailing during the preseason (working the maximal strength base at full ROM) and, subsequently, incorporating partial squats as the competitive period approaches (working maximal strength at a more specific ROM for sprinting) (Möck et al., 2021; Fossmo et al., 2022; Seitz et al., 2014; Bazyler et al., 2014; Valamatos et al. 2018).

Explosive strength

Explosive strength or power training has a great specific transfer to sprinting and is fundamental during the season, especially in the final part of the macrocycle. The goal is to move loads of 30-80% of 1 RM at maximum speed. Explosive strength exercises allow acceleration to be maintained throughout the movement unlike maximal strength exercises, where a deceleration of the load is required at the end of the movement (it can take up to 45% of ROM at loads close to 1 RM). Explosive strength work produces improvements mainly on neuromuscular function (recruitment of motor neurons and motor units), but also at the level of intramuscular and intermuscular coordination. Likewise, explosive strength work has greater performance on the vertical force vector and, therefore, greater transfer to the maximum speed phase of the sprint (Suchomel et al., 2018; Möck et al., 2021; Morris et al., 2022).

Free weight multi-joint exercises (Olympic bar) are recommended, highlighting the Olympic lifts (snatch, clean and jerk) with all its variants (power, hang and pulls) and jump squats. The recommended work are sets of 2-4 repetitions with a load of 30-80% of 1 RM (30-60% for jump squats and 60-80% for Olympic lifts), recovery of 2-3 minutes and a total volume of 2-4 sets. Technically, focus should be on performing the concentric phase at maximum speed (especially the triple hip-knee-ankle extension during the second pull phase), controlling all the sub-movements that make up the Olympic lifts (deadlift, clean/snatch pull, front/overhead squat and jerk) and cushioning the catching of the barbell (Olympic lifts) or jump landing (jump squat). Deterioration of technique and moderate loss of execution speed (up to a maximum of 25%) are very useful indicators for programming recoveries and the total volume of work sessions, as well as for considering their end when they occur (Suchomel et al., 2018; Möck et al., 2021; Morris et al., 2022).

Within the explosive strength work, there are some star exercises for sprinting: weightlifting pulling derivatives (clean/snatch pull, mid-thigh pull, hang high pull, and jump shrug). These are variants of the clean and snatch that focus on the second pull and eliminate the barbell catch (fundamental in learning the complete movement). They are especially interesting for the masters sprinter, as they specifically work the triple hip-knee-ankle extension (the determining movement in the sprint) with less technical difficulty and less joint effort. They also allow to increase the workload (80-100% of 1 RM) in earlier phases of the season (Suchomel et al., 2015; Suchomel et al., 2022).

Reactive strength

The reactive or elastic strength training par excellence is plyometrics, which consists of jumping at different intensities. It is an excellent method for transferring any type of strength work to sprinting and jumping, and for preventing injuries (it favours collagen synthesis in the connective tissue), so its training is very beneficial throughout both the season and off-season. The aim is to optimize the stretch-shortening cycle of the muscle, through an initial eccentric contraction that facilitates and enhances a more efficient subsequent concentric contraction (the transition phase between the two must be very fast so that the kinetic energy produced is not dissipated in the form of heat). Plyometric work produces an improvement in sprinting performance (up to 0.1 seconds in 50 meters) and jumping (up to 4 cm). Horizontal jumps (especially unilateral exercises) appear to provide 20-25% more peak power (especially in the ankles) and greater transfer to sprinting than vertical jumps, but they also generate greater joint stress and should therefore be limited (Suchomel et al., 2018; Morris et al., 2022; Lievens et al., 2021; Watkins et al., 2021).

Horizontal jumping exercises (bounces and bounds) and vertical jumping exercises (hurdles and box) are recommended, both low intensity (bounces and hurdles/box <30 cm) and high intensity (bounds and hurdles/box >30 cm). The recommended work are sets of 4-8 jumps, 1-2 minutes recovery and a total volume of 60-200 low intensity jumps and <60 high intensity jumps. High intensity sessions must be separated ≥1 week (Lievens et al., 2021; Watkins et al., 2021).

Preventive strength

Injuries—acute and overload—are a constant threat to the masters sprinter, due to the aging or degeneration of the musculoskeletal system and the stress to which the tissues involved in sprinting are subjected. The main risk factors for injury are previous injuries, muscle agonist/antagonist imbalance, muscle overload/fatigue, poor warm-up, and dehydration. The muscle-tendon unit contributes to 51% of a joint's flexibility and sends information to the central nervous system (via proprioceptors) about body posture, centre of gravity and joint angular velocity. Preventive strength training therefore reduces the risk of injury by up to 70% and is recommended throughout the season (perhaps more so in pre-season) and also in the off-season. The aim is to strengthen and precondition the muscles and tissues adjacent to joints and muscles, redistributing the total load. This effect is dose-dependent, so that a 10% increase in strength training volume is associated with a 13% reduction in relative risk. Preventive strength training includes eccentric work, which produces a lengthening of muscle fascicles and improves ROM comparable to ballistic stretching (although less than static stretching); and proprioceptive work, which strengthens tendons and ligaments and improves core stability, centre of gravity control, pelvic control and limb coordination (Lauersen et al., 2018).

Within the eccentric work, exercises with weight machines are recommend, preferably unilateral, highlighting the hip and knee extensions, the femoral curl, and the calf and soleus raises. The recommended work are sets of 6-8 repetitions with a load of 60-80% of 1 RM, 1-2 minutes recovery and a total volume of 3-5 sets. Technically, focus should be on controlling and lengthening the eccentric phase for ≥ 5 seconds (Suchomel et al., 2018; Vetter et al., 2022).

Within proprioceptive work, squats, lunges and planks on unstable platforms (pads, BOSU or Swiss ball) and with body weight or 10% more (vest, dumbbells or barbell) are recommended. The recommended work are 30-second sets circuits, 1-2 minutes recovery and 20- 30 minutes total volume. Technically, the focus should be on controlling body posture and motor gesture (Romero-Franco et al., 2012).

WARM UP

The main objectives of the warm-up are: to increase body temperature; to increase cardiac output and muscle blood flow; to optimize energy metabolism and oxygen consumption; to reduce joint and muscle stiffness; and to improve nerve conduction and muscle contraction. In order to achieve all of the above, the warm-up should include the following: aerobic running, stretching (mainly dynamic), specific sprinting exercises (running technique, progressives and starts) and post-activation strengthening (jumps or squats) (McGowan et al., 2015).

Aerobic running

Aerobic running (5-10 min at 65% of maximum heart rate) has as main objectives the increase of core temperature, cardiac output and oxygen consumption. Increasing core temperature by 1°C improves sprint performance by 2-5% by increasing ATP turnover and anaerobic glycolysis. Increased oxygen consumption improves overall performance by increasing motor unit recruitment, oxidative enzyme activity and anaerobic reserve (McGowan et al., 2015).

Stretching

Stretches are exercises whose main objectives are to increase joint mobility or range of motion (decrease muscle-tendon stiffness) and muscle performance (increase temperature and neuromuscular potentiation). Although they are routinely included as part of any sprint training program, there is some controversy about the actual benefit of the different types of stretching (static, dynamic and proprioceptive neuromuscular facilitation).

Static stretching prior to sprint, jump, strength and power training worsens performance (it does not increase muscle temperature or neuromuscular potentiation), except in athletes with a very low range of motion. It seems that this negative effect is counteracted if they are performed >15 minutes before training, the duration is <30 seconds per muscle, the intensity or amplitude is submaximal and, finally, they are followed by a general warm-up including dynamic stretching.

Dynamic stretching—speed and controlled amplitude—prior to sprint, jump, strength and power training improves performance, especially when performed at higher speeds (increases muscle temperature and facilitates neuromuscular recruitment). However, ballistic stretches—extreme speed and amplitude—appear to provide less of an improvement (they may stimulate muscle mechanoreceptors and inhibit presynaptic nerve stimulation and muscle contraction). It seems that the beneficial effect of dynamic stretching increases when performed while walking and when associated with certain strength work (front squats) and decreases when the duration or volume of such stretching is excessive.

Proprioceptive neuromuscular facilitation prior to sprint, jump, strength and power training appears to provide no benefit on performance (although the evidence is very limited) (Opplert & Babault, 2018; Peck et al., 2014; Behm & Chaouachi et al, 2011).

Specific exercises

Running technique work breaks down the sprint into simpler, easier to control movements, on which to achieve improvements and subsequent positive transfers to the full movement. It is carried out through walking, bouncing or jumping exercises (with or without hurdles), and should focus on very specific aspects, such as body posture, elevated hips and knees, forefoot support or ankle reactivity. This work improves proprioception and sprint performance (30 meters), with better overall results in exercises focused on stride frequency. The latter are associated with better times in the first 15 meters, while the exercises focused on stride length are associated with better times in the second 15 meters (Gil et al., 2019).

Acceleration sprints or build-ups (5 x 40 meters finished at 90-95%) produce an increase in nerve conduction of up to 12% and an improvement in sprint performance (50-60 meters) (McGowan et al., 2015; Gil et al., 2019).

Post-activation potentiation

Post-activation potentiation consists of short, explosive exercises (squats and jumps) prior to sprinting (1-10 minutes), which increase muscle strength and improve performance. They produce increased nerve conduction, increased recruitment of motor units (especially type II), increased contraction capacity (increased intramuscular calcium concentration) and better synchronization of muscle fibres (increased myosin phosphorylation). Potentiation work produces an increase in strength for a limited time, so it should be performed a few minutes before the sprint but with sufficient rest to avoid muscle fatigue.

Partial squats (quarter or half), with submaximal load (60-90%) and few repetitions (≤10) enhance muscle activation and improve up to 3% sprint performance (20-40 meters) after 5-10 minutes rest. They seem to have a greater effect on frequency than on stride length. Stronger athletes or athletes with greater experience in strength work (>3 years) benefit more from this type of exercise (by causing greater fatigue).

Plyometrics (depth jumps or jump squat) with few repetitions (≤10) seem to enhance greater activation than loaded squat (by producing greater specific recruitment of type II units and less fatigue), improving sprint performance (20-50 meters) by 5% after ≤5 minutes of rest. They appear to have a greater effect on stride length than on stride frequency. Less strong athletes or athletes with less experience in strength work (<3 years) benefit more from this type of exercise (by causing less fatigue) (Suchomel et al., 2018; Gil et al., 2019; Borba et al., 2017; Seitz et al., 2016).

RECOVERY TRAINING

Recovery run

Active recovery in sprinters is carried out in the form of tempo runs on the days following high-intensity training, providing the following benefits on the muscle: increases capillary density, oxygen supply and elimination of waste products; relaxes muscle tone; and improves aerobic capacity. This work should be performed on a soft surface (grass or turf), at short intervals (50-200 meters), low intensity (60-70%), with little rest (30 seconds to 1 minute), and a total volume with a 2:1 ratio with respect to sprint training (1000-2000 meters) (Haugen et al., 2019).

Myofascial release

Muscle fascia is a connective tissue that surrounds and connects all muscles, facilitating their mobility and elasticity. Myofascia can contract in response to stress or injury and produce tissue adhesions or scarring, which can promote the formation of sore spots. Myofascial release with roller or massage gun (for 1 minute per muscle) increases blood flow and reduces tissue adhesions and scarring, facilitating soft tissue restoration and plasticity. It appears to increase joint range of motion (up to 15%) and muscle performance (up to 7%) when combined with dynamic stretching during warm-up. It also promotes muscle recovery during cool down (Romero-Moraleda et al., 2020; Capote Lavandero et al., 2017).

Cryotherapy

Cold therapy (ice or cold water immersion) after sprinting or strength training decreases fatigue and delayed onset muscle soreness and improves recovery. Such repair is related more to the decrease in intramuscular temperature—reducing the inflammatory response and cellular metabolic activity—than to the decrease in muscle blood flow. Cryotherapy is most effective when a muscle temperature of 10-20ºC is reached for 10 to 30 minutes immediately after or within 12 hours after intense sessions or with little recovery time in between. However, its regular use should be avoided after routine sessions or with sufficient recovery time, as it can reduce the anabolic capacity of the muscle (decreasing protein synthesis and accumulation) and attenuate the mechanisms of muscle adaptation to training (Kwiecien & McHugh, 2021; Bleakley et al., 2012).

INVISIBLE TRAINING

Nutrition

Although the training of the masters sprinter includes low volumes and prolonged recovery periods, nutrition plays a fundamental role in optimizing performance and adaptations. Since one of the bases of sprinting is power, and power is proportional to the degree of muscle hypertrophy in relation to weight, nutrition must favour this muscle-to-weight ratio.

Energy requirements relative to body weight are not high, so carbohydrate intake must be moderate (3-6 g/kg/day). This intake should always be close to the daily training: prior to it in order to ensure energy and performance; and also after it in order to favour the replenishment of glycogen deposits in the muscle and recovery.

Protein requirements in sprinters and power-strength trainers are high, up to double the normal daily recommendations (2-2.5 g/kg/day). The aim is to promote muscle mass gain and counteract sarcopenia in advanced age, as well as the repair of damaged tissues. Intake should ideally be divided into meals with 0.4 g/kg of high biological value or rich in essential amino acids protein every 3-5 hours.

Water requirements in sprinters are not high, except in speed endurance sessions (higher volume). It appears that some degree of dehydration leading to a reduction of up to 2-3% of body weight can improve power-to-weight ratio and acceleration. Therefore, water intake during training should be adjusted to thirst and gastric tolerance, in order to avoid outright dehydration (especially in speed endurance sessions) but also hyperhydration (especially in acceleration and maximum speed sessions). This should always go hand in hand with adequate fluid and electrolyte replenishment in post-workout recovery.

One of the most important moments of sprint training is the post-workout recovery snack. Early (≤1 hour) and combined intake of carbohydrates (0.8 g/kg) and protein (0.4 g/kg) favours the rapid restoration of muscle glycogen stores, muscle protein metabolism and muscle damage generated during training. The addition of proteins to carbohydrates enhances the actions described above and, in particular, makes it possible to reduce by 30% the amount of carbohydrates necessary for glycogen resynthesis. It is also interesting to include phytonutrients—berries—in this snack (and, in general, in the daily diet), given their antioxidant and repairing effect on damaged muscle (Slater et al., 2019; Tipton et al., 2007).

Supplements

The use of supplements is quite common in sprint training and competition to enhance performance and recovery. Aside from the generic use of vitamins, minerals and amino acids, there are a number of supplements that are more specific to sprinting.

Creatine (2-5 g/day) induces the prephosphorylation of high-energy phosphates by increasing muscle stores and ATP availability. This favours performance and adaptations in short or alactic sprint training and in explosive strength work of up to 30 seconds duration.

Bicarbonate (0.3 g/kg pre-training) and *Beta-alanine* (3-6 g/day) counteract—at blood and muscle level respectively—the acidosis derived from the accumulation of lactate generated during anaerobic glycolysis (predominant energy system in sprinting). This favours a 1-3% increase in performance and adaptations in long or lactic sprint training, as well as in strength-endurance work of up to 1 minute duration.

Nitrates (10 mg/kg/day) enhance muscle vasodilation and oxygenation, especially in type II fibres. This improves performance and adaptations by 3-5% in different types of sprint training and strength work of up to 10 minute duration.

Caffeine (3-6 mg/kg pre-training) activates the nervous system, increasing neuromuscular transmission, catecholamine release and alertness, and reducing the sensation of fatigue. This produces >3% gains in performance and adaptations in sprint training and strength work of up to 2 minute duration.

BCAA (branched-chain amino acids)—leucine, isoleucine and valine—make up 30% of skeletal muscles and their supplementation (250 mg/kg/day) counteracts proteolysis or protein degradation generated during lactic anaerobic glycolysis. This promotes recovery after long sprint and strength-endurance training and reduces delayed onset muscle soreness (24-72 hours later).

Glutamine (non-essential amino acid) makes up 60% of skeletal muscles and is a precursor of glutathione (potent antioxidant) and transporter/remover of ammonia (potent toxin). Its supplementation (5-10 g/day) counteracts proteolysis, inflammation and acidosis generated during lactic anaerobic glycolysis. This favours recovery after long sprint and strength-endurance training, and reduces delayed onset muscle soreness (Slater et al., 2019; Tipton et al., 2007; Peeling et al., 2019; Tan et al., 2022; Weber et al., 2021; Coqueiro et al., 2019).

Sleep

The masters sprinter requires more sleep than normal as part of the recovery strategy. Sleep hygiene includes, as main objectives, a minimum number of hours of sleep at night and a supplement in the form of a postprandial nap.

Night-time sleep (7-9 hours) promotes the release of anabolic hormones—insulin, testosterone, somatotropin (GH) and somatomedin (IGF-1)—which promotes protein synthesis and tissue repair. This facilitates muscle recovery, prevents injuries and counteracts sarcopenia.

Short postprandial naps (20 minutes) have a beneficial effect on sprint performance by improving reaction time and acceleration, as well as increasing plasma antioxidant levels. Long naps (90 minutes) and/or not separated at least 30 minutes from the start of training are associated with sleep inertia (decreased cognitive capacity after awakening) and lack of arousal, decreasing performance. Likewise, naps should be taken before 4 p.m. so as not to interfere with nocturnal sleep (Vitale et al., 2019; Bird et al., 2013; Dattilo et al., 2011; Romdhani et al., 2021; Lastella et al., 2021).

SUMMARY

The final reflection of this review can be carried out through the following key ideas:

Less is more

The volume of training sessions should be determined and adapted based on the intensity and performance of the work, so that sessions should be reduced in volume or end with a drop in performance and/or deterioration of technique. On the other hand, recovery times must be strictly adhered to as they may modify the work objective of the session (especially when full recovery is sought). In view of the above and as a general rule, any masters sprinter training program should be planned with lower volume and higher recovery sessions and cycles.

Strength is a force for good

Strength training is one of the pillars of the masters sprinter's training and must be present throughout the season. Maximum strength work to counteract sarcopenia and preventive strength work to prevent injuries should prevail. Deterioration of technique and loss of execution speed are determining factors for optimal performance and must be taken into account when scheduling work sessions and ending them when they appear.

Listen to your body

The recovery strategy is another of the mainstays of the master sprinter's training, being definitive to improve performance and prevent injuries. Apart from the "*guideline*" in these strategies, you must "*listen to your body*" before starting each training session. Thus, if there is a sensation of muscle overload, the warm-up can be started and, if it persists, the sprint/strength work session should be modified (reduce volume and/or intensity) or move on to a recovery work session (tempo run, myofascial release and/or static stretching). If there is pain beyond the sensation of overload, do not train (do not even warm up) and consider a physiotherapy session.

Eat and nap to tune up

Invisible training should be a must-do for the masters sprinter, as it improves performance and, above all, recovery. Within this, two particularly interesting measures must not be missing because they are effective and easy to comply with: the post-workout snack and the postprandial nap.

AUTHOR CONTRIBUTIONS

Ramón Eizaga Rebollar carried out the literature search, drafted the initial manuscript, and reviewed and approved the final manuscript. María Victoria García Palacios supervised the data collection and the manuscript preparation, and critically reviewed and approved the final manuscript.

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