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Mixed methods strength training for the masters athlete: A review.

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Abstract

Participation numbers in masters sport demonstrate that masters sport in Australia and throughout the world is on the increase. Despite this, research focused on performance enhancement in masters athletes is lacking. Age-related changes in morphological, neuromuscular and biochemical factors help explain why sprint performance declines with age. Current strength training guidelines for older adults recommend older adults perform two strength training sessions per week, with each session including eight to ten different exercises for each of the major muscle groups. In addition, older adults should perform 8-12 repetitions of each of these exercises, at a moderate to vigorous intensity. However, to improve sprint performance, more complex training strategies may be necessary. A *Sports Discus* database search of the academic literature was performed using the following terms: “masters athletes AND mixed methods”, “Mixed method training AND older adults” “Sprint performance AND masters athletes”. Literature was also sourced from the reference lists of peer-reviewed papers arising from the search above. The literature reviewed for this article is comprised of 50 original investigations and four reviews. The present review of the mixed methods strength training literature suggests the inclusion of a 20 week mixed methods strength training program into a masters athlete sprint training program may lead to improvements in sprint performance. Furthermore, the development of a comprehensive training program for a masters athlete including strength, speed, recovery and nutritional considerations is provided.

Introduction

Society has long thought it unusual for any individual over 40 years of age to compete in organised sport. Slowly this is changing, as numbers of older individuals begin to take up sport later in life. The most recent statistical data shows in 1997, there were 1,352,800 Australians aged 45 years and older involved in sport ^[3].

Several definitions exist for the term masters athlete that vary between different sporting organisations. For example, in swimming the masters competitors begin at the age of 25, golf at 50 years, and track and field masters athletes after age 35 years ^[36]. For the purpose of this review, the definition of a masters athlete is any individual who systematically trains for and competes in, organised forms of competitive sport specifically designed for older adults ^[36].

The increasing participation of athletes in the World Masters Games is further evidence that older adults are becoming more involved in competitive sport. According to the International Masters Games Association, the first World masters Games held in Toronto, Canada in 1985 attracted 8,305 competitors and in the most recent 2009 Games held in Sydney Australia, there were 28,676 competitors ^[52]. Within Australia, similar trends show participation in the Australian Masters Games between 1987 – 1997 grew by 58%, this is still growing today ^[3]. Finally, reports from many sporting bodies in Australia indicate that masters are the fastest growing area in their sport in terms of numbers of participants ^[3].

In the quest to remain competitive, masters athletes may seek professional strength and conditioning coaches (SCC) guidance as they strive to improve their physical performance. Current strength training guidelines from the American College of Sports Medicine, recommend older adults perform two strength training sessions per week with each session including eight to ten different exercises for each of the major muscle groups. Additionally, older adults should perform 8-12 repetitions of each exercise at a moderate to vigorous intensity ^[50]. Currently, these are the only guidelines available for masters athletes and SSC to refer to.

While these guidelines may be suitable for a novice masters athlete with no strength training experience, intermediate to advanced masters athletes with significant strength training experience may need more complex resistance training strategies. To further complicate matters, age related changes in many of the physiological systems related to sporting performance ^[35,36] means that the guidelines currently established for younger athletes may not apply to masters athletes.

Therefore, the purpose of this article is to develop a detailed training program for a masters athlete and review the age related changes that affect sprint performance in masters athletes. A review of the mixed methods strength training literature suggests the inclusion of a 20 week mixed methods strength training program into a masters athletes sprint training program may lead to improvements in sprint performance.

METHODS

A *Sports Discus* database search of the academic literature was performed using the following terms: “masters athletes AND mixed methods”, “ Mixed method training AND older adults” “Sprint performance AND masters athletes”. Literature was also sourced from the reference lists of peer-reviewed papers arising from the search above. The literature reviewed for this article is comprised of 50 original investigations and four reviews.

Review Outcomes

Minimal research relating to anaerobic performance in masters athletes has been undertaken. In their recent study Gent and Norton^[13] examined aerobic power and both anaerobic power and capacity in a cross section of 156 male and 17 female highly trained masters cyclists aged between 35 and 64 years. Anaerobic power and capacity was measured using maximal 10- and 30 second cycle Ergometer tests. They observed an age-related decline in anaerobic power ($8.4 \pm 4.1\%$) and capacity ($8.0 \pm 3.3\%$), despite the participant’s high level of regular physical training. The total number of female athletes was too small for separate data analysis. Moreover, the decline in anaerobic performance was greater than declines in aerobic performance. Other researchers^[23] reported similar decreases in anaerobic power in a group of formerly highly trained oarsmen and kayakers aged 30-67 years who were still recreationally active. Faulkner^[14] has also reported that the decline in anaerobic performance is greater than the decline in aerobic performance with advancing age, thus highlighting the vulnerability of the anaerobic energy system in masters athletes. Taken together, it appears anaerobic performance declines with age, even among masters athletes who regularly perform high levels of physical training.

The observed decline in anaerobic performance in masters athletes is likely due to morphological, neuromuscular and biochemical changes that occur with age. Morphological changes include a decline in muscle mass ^[2,36,4,], decline in type II muscle fibre area ^[4,10] and changes in muscle architecture which include pennation angle and fascicle length ^[6,36]. Secondly, neuromuscular changes include a decrease in rate of force development ^[5,18], type II muscle fibre denervation ^[9] and decreased inter-muscular coordination ^[19]. Finally, biochemical changes include decreased concentrations of intramuscular phosphocreatine and a decrease in the ratio of phosphocreatine to inorganic phosphate ^[28].

In their review on anaerobic performance in masters athletes, Reaburn and Dascombe ^[36] also found that anaerobic performance is dependent on muscle mass, muscle fibre type, muscle fibre size, muscle architecture and strength, substrate availability, metabolic pathway efficiency, accumulation of reaction products, heredity and physical training. Taken together, it is apparent that morphological, neuromuscular and biochemical factors play a role in the observed decline of anaerobic performance in masters athletes.

Strength training programs are a proven method in improving anaerobic performance in younger athletes ^[11,34,53]. Pattern and Hopkins ^[34] in their study, combined explosive training (20 repetitions of explosive single leg jumps) with high resistance cycle sprints (five x 30 second cycle sprints at 60-70⁻¹ min) three times per week, for five weeks in a group of well-trained (29.2 +/- 8.4 years) cyclists. Significant improvements in cycle sprint performance following resistance training were observed. To date, only two research studies have examined the effect of a mixed methods strength and sprint training program in masters athletes ^[8,40] with one other study having investigated the effectiveness of mixed methods strength training in healthy older adults ^[31].

In their study, Newton and Kraemer^[31] examined the effect of a 10-week mixed methods strength program on leg strength and muscular power in eight young (30.6 ± 5.0 years) and 10 older (61.0 ± 4.0 years) recreationally active, but not strength trained men.

Subjects participated in a non linear strength training program consisting of three training sessions per week over a ten week period. Training sessions included squats, leg extension and leg curl, bench presses and calf raises on machines, trunk flexions and extensions using free weights. The format of this training program has been proven to elicit a large response by the endocrine system and therefore lead to greater stimulus to increase muscle size^[31].

The three training sessions were divided into a hypertrophy training session (3-6 sets of 8-10 repetitions with 1 minute rest), a strength training session (3-6 sets of 3-5RM loads) and a power training session (3-6 sets of 6-8 lower load repetitions, participants were instructed to performing the concentric phase as fast as possible on leg extensions and squats). The volume of training was progressed throughout the 10 week, non linear periodized program. Subjects continued their normal recreational physical activities (bike riding, walking and jogging) one to two times per week. At the completion of the 10 week mixed methods strength program, the researchers observed significant increases in isometric squat strength ($40.0 \pm 42.0\%$), jump squat power ($36.0 \pm 23.0\%$), jump squat force ($29.0 \pm 14.0\%$) and quadriceps EMG activation ($43.0 \pm 64.0\%$) in the older adults. Younger males also had significant increases in isometric squat strength ($23.0 \pm 15.0\%$), jump squat power ($33.0 \pm 16.0\%$), jump squat force ($29.0 \pm 13.0\%$) and quadriceps EMG activation ($40.0 \pm 47.0\%$). Taken together, it appears older men demonstrate similar capacity to younger men for increasing these variables, following an appropriately periodised resistance training program.

In an earlier study focused on masters track athletes, Reaburn^[40], examined the effect of an 8-week hypertrophy training program on 100 and 300 meter sprint performance, muscular strength and thigh girth (measured anthropometrically) in eight sprint trained male runners

aged 45-79 years. Strength training took place three times per week (on alternative days) for an eight week period under the supervision of a experienced and qualified trainer. The participants performed three sets of 12,10 then 8 repetitions at 80% of 1RM with one minute rest between sets. Exercises selected included leg extensions, leg curls, leg press, half squats, bench press, upright row, bicep curl, tricep push down and abdominal crunches. 1RM capacity was measured every 2 weeks to adjust training loads appropriately. Subjects were instructed to maintain their normal sprint training regime over the period of the study. At the completion of the eight week hypertrophy training program, significant increases in strength, thigh girth ,100 and 300 meter sprint performance were observed.

More recently, Cristea and colleagues ^[8] investigated the effect of a 20 week concurrent sprint, strength and power training program on sprint performance, morphological and neurological adaptations in seven sprint trained masters track athletes (aged 66.0 ± 3.0 years) who had no previous strength training experience. The researchers designed the training program based on knowledge obtained from similar research previously conducted on younger adult athletes. The mixed strength and power training program was designed to increase explosive power, strength and muscle hypertrophy, while concurrently performing sprint training to improve acceleration and maximal speed. Strength training sessions were performed twice per week as were sprint training sessions, both were performed on non-consecutive days.

The training program was further sub-divided into three, three to four week cycles in Phase one, Phase two used a further three, four week cycles. The cycle involved hypertrophy training protocols (3-4 sets, 8-12 repetitions at 50-70% 1RM). The second and third cycles involved combined plyometric, maximal strength and explosive weight training (strength exercises used 4-6 repetitions at 70-85% 1RM, explosive exercises (high-load speed strength) used 2-3 sets of 4-6 repetitions at 35-60% 1RM, the plyometric exercises (low-load speed strength) used 2-3 sets of 3-10 repetitions). Phase two used similar exercises and repetition ranges as used in

phases one, but with a general increase in intensity with a subsequent reduction in training volume across both sprint and strength training exercises.

The sprint training program was designed to improve both acceleration and peak sprinting ability. During the first phase, the sprint runners performed five x 200-250 meter runs at 75-85% of maximum speed. The field sprint sessions were purposefully designed to develop speed endurance with low volumes to accommodate the strength training program. To develop acceleration, the athletes performed four x 30 meter sprints at 80% of maximal effort. During the second and third training phases, sprint intensity was gradually increased until near maximal speeds were reached. Workouts included two to three reps of 30-80 meter sprints at 90-98% effort.

At the conclusion of the 20-week training period, the researchers reported significant increases in 10 meter sprint velocity (4%), 60 meter sprint time (2%), 1RM squat strength (27%), squat jump (10%), triple jump (4%). In addition, the participants demonstrated significant morphological changes including hypertrophy of type IIA muscle fibres (40%). Neurological changes included an increase in reactive jump power (29%) and jump squat iEMG (9%). These results demonstrate mixed methods strength training programs are effective at improving strength, power and sprint performance in masters sprinters.

In conclusion, the limited research suggests both healthy older adults and masters athletes remain responsive to mixed methods strength training programs. Furthermore, sprint performance in masters athletes, may be improved by the inclusion of a mixed methods strength training program

PRACTICAL APPLICATIONS

Considering the marked age related changes in muscle morphology, neuromuscular structures and muscle cell fuel sources and the fact that research has shown these are all improved through resistance training ^[8,40,31]. It seems a logical decision to incorporate a strength and power training program into the masters athletes training regime.

However, before implementing any training program with a masters athlete, the strength and conditioning coach should consider the health history of each individual masters athlete. The American Heart Association (AHA) ^[25] recommends prior to engaging in vigorous exercise, the following medical pre-screening and assessment of possible cardiovascular complications should be undertaken with masters athletes:

Family History

- Heart disease in surviving relatives
- Premature sudden death

Persona History

- Heart murmur
- Systemic hypertension
- Unusual fatigue
- Syncope
- Exertional dyspnoea
- Exertional chest Pain

Physical Examination

- Resting blood pressure
- ECG stress test with blood pressure measurement

- Femoral pulses
- Stigmata of Marfan syndrome

Further to this, it also recommended that the strength and conditioning practitioner review any orthopaedic conditions with their masters athlete. Such conditions include arthritis, osteoarthritis and osteoporosis, joint replacements and other related surgery. The strength and conditioning coach is recommended to refer any masters athlete with medical or musculoskeletal risk factors to a sports medicine practitioner.

Finally, regular performance and event or sport specific assessments are also required when training a masters athlete. The strength and conditioning coach should conduct a relevant battery of performance assessments to track and monitor performance improvements throughout the training program.

Coaching Considerations

Many strength and conditioning coaches may ask “How do I coach a masters athlete, is it different”? Whatever the age of an athlete, the most important consideration is the athlete themselves and what they need to get out of the training program ^[37]. The strength and conditioning coach does need to be smarter about a masters athletes training, because with increasing age comes increases in risk if training is not carefully managed. Some important coaching considerations for the Masters athletes ^[22] include:

Masters athletes have different physical characteristics than younger athletes, they may need to train some of these characteristics differently than younger athletes.

1. Masters athletes are more likely to have certain health conditions such as osteoarthritis, thus requiring training to be adjusted accordingly.
2. Prefer having input into the coaching session, and will be less likely to respond to a didactic model of coaching, often used with younger athletes.
3. May have difficulties in completing scheduled training sessions due to fatigue, work and family commitments or other responsibilities.

The masters athlete is an “athlete” with real sporting ambition. Successful performance is just as important to a masters athlete, as it is to any younger athlete. Don’t underestimate their commitment. Coaching a Masters athlete should be no different than coaching other younger athletes ^[22].

Strength and Conditioning Programs for the Masters Athlete

The following suggested mixed training programs incorporate the key factors previous research ^[8,31,40] has suggested are needed for older active individuals and masters athletes.

These include hypertrophy training to offset the age related decrease in muscle size, heavier strength training to stimulate fast twitch muscle fibres and motor units, and explosive power weight training exercises and plyometrics to maximize neuromuscular stimulation.

The proposed 10 week program below may suit a masters athlete not currently engaging in concurrent sprint speed training and may serve as an effective pre-season program. Program is adapted from Newton & Kraemer ^[31]. Remember each masters athlete will present different levels of physical preparedness so be prepared to modify the program where necessary through changes in exercise selection (machine based vs free weights), loading (taking longer to progress through loading phases) and increasing recovery time between sessions.

Table 1.1: 10 week non-linear periodisation table.

Weeks	1	2	3	4	5	6	7	8	9	10
Hypertrophy	3x10	3x8	4x10	4x8	5x10	5x8	4x10	4x8	6x10	6x8
Strength	3x5	3x3	4x5	4x3	5x5	5x3	4x5	4x3	6x3	6x5
Power	3x6	3x8	4x6	4x8	5x6	5x8	4x6	4x8	6x8	6x6

*Unload weeks 7 and 8. There is a increase in load every two weeks, the volume is also progressing over the 10 week period.

Table 1.2: Sample week 1 training schedule.

	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
Training Component	Hypertrophy	Relevant Energy system conditioning	Strength	Relevant Energy system conditioning	Power	X-Training	Rest/Active Recovery
Sets x Reps	3 x 10		3 x 5		3 x 6		
Load	10RM or 75% 1RM		5RM or 85% 1RM		30% 1RM		
Rest	1 minute		2-3 Mins		3 Mins		
Tempo	3:1:2		1:0:1		Explosive		

Table 1.3: Weekly training schedule – week 1 example.

HYPERTROPHY EXERCISE SELECTION	STRENGTH TRAINING EXERCISE SELECTION	POWER TRAINING EXERCISE SELECTION
Leg Press	Half squats	Jump Squats
Chest Flys	Bench Press	Bench Throws
Leg Extensions	Romanian Dead lifts	Power Cleans from the rack
Lateral raises	Reverse grip chin ups	Plyometric Hops
Leg Curls	V-ups	
Seated Rows		
Abdominal curl ups		
Prone Trunk Extensions		

*** Exercises in table 1.3 are a guideline to what was used in the original research study^[31]. Strength and conditioning coaches should use their own discretion as to what exercises are appropriate and/or need modification, when training a masters athlete.*

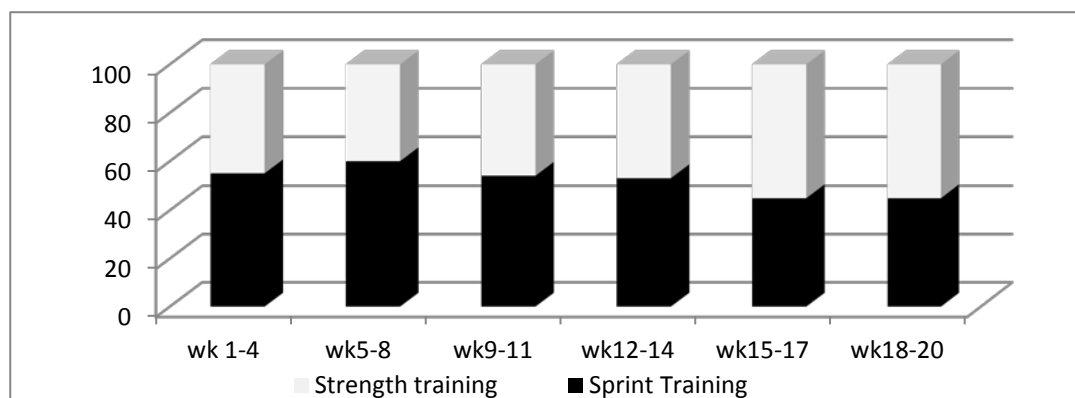
Concurrent Strength and Sprint Training Program for the Masters Athlete.

Below is a suggested example of a mixed training program with concurrent sprint training incorporating strength, power and plyometric elements with alternate day sprint training. The aim of this program is to concurrently improve strength, power, muscle mass and sprint performance.

TABLE 2.1: 20 week mixed strength method training program with concurrent sprint training.

Weeks	1-4	5-8	9-11	12-14	15-17	18-20
	PHASE 1			PHASE 2		
Reps	H: 8-12	S: 6	S: 4	H: 8-12	S: 6	S: 4
		EE: 6	EE:: 4	S: 6	EE:: 4-6	EE:: 4-6
		Ply: 10	Ply: 8	Ply: 6	Ply: 8	Ply: 8
Sets	H:4	S: 3	S: 3	H:3	S: 4	S: 4
		EE:: 3	EE:: 4	S: 3	EE:: 4	EE:: 4
		Ply: 2	Ply: 2	Ply:3	Ply: 2	Ply: 2
Load (IRM)	H: 50-60%	S:75%	S:80%	H:70%	S:80%	S:85%
		EE:: 35%	EE:: 40%	S: 85%	EE:: 50%	EE:: 60%
		Ply:80 FC'S	Ply:90 FC'S	Ply: 100 FC'S	Ply: 110FC'S	Ply:120 FC'S
Rest	1 minute	2-3minutes	S/Ply: 2-3mins	H: 1 min	S/Ply: 2-3mins	S/Ply: 2-3mins
				S/Ply: 2-3mins		3mins

TRAINING VOLUMES



*H = Hypertrophy, S = Strength, EE = Explosive Exercises, Ply = Plyometric Exercises

Table 2.2: Weekly Training Schedule –a non-competitive phase mixed training program weekly training schedule.

	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
Training Component	Weight Training	Plyometric + Sprint/Speed training	Weight Training	Plyometric + Sprint/Speed training	Weight Training	X-Training	Rest/Active Recovery

Table 2.3: Exercise Selections.

HYPERTROPHY EXERCISE SELECTION	STRENGTH TRAINING EXERCISE SELECTION	EXPLOSIVE WEIGHT TRAINING EXERCISE SELECTION	PLYOMETRIC EXERCISE SELECTION
Leg Press	Half Squats	Clean Pulls	Mini Hurdle Jumps
Chest Press	Romanian Deadlifts	High Pulls	Horizontal Bounds
Lat Pull Downs	Bench Press	Jump squats	Vertical Jumps
Seated Shoulder Press	Dumbbell rows	Push Presses	DB shoulder/arm sprint movements
Cable Hip flexion's & Extensions	Standing barbell presses		
Leg extensions	Trunk Extensions		
Leg curls	Trunk Flexions		

Table 2.4: Sample Phase one strength and power training session.

Week: 5 Training Session: Strength & Power				
Day: Monday				
10 Minute Functional Warm up: <ul style="list-style-type: none"> • 5 minute nonspecific aerobic warm up (stationary bike) • Lunge walk with trunk rotations x 10 • Mini jump squats x 10 • Skipping x 20, two sets • Walking hip rotations 				
Exercise	Sets	Reps	Load	Tempo
Clean Pulls	3	6	35% 1RM	Explosive
Push Presses	3	6	35% 1RM	Explosive
Half Squats	3	6	75%1RM	2:0:1
Bench Presses	3	6	75%1RM	2:0:1
Modified Curls ups	3	6	Approx. 6rm load	
Four point opp. Arm/leg raise with ankle weights	3	6	Approx. 6rm load	
Cool Down: <ul style="list-style-type: none"> • Static Stretching for upper and lower limbs • Foam roller releases for trunk, hips and lower limb's • If available vibration plate massage for trunk, hips and lower limb's 				

Table 2.5: Power and sprint training session plan.

Week 5 Training Session: Power & Speed Development				
Day: Tuesday				
10 Minute Functional Warm up: <ul style="list-style-type: none"> • Slow 400 meter jog • Dynamic stretching – leg swings • High knee skips • Heel to bum skips 				
Plyometric Exercises	Sets	Reps / Recovery	Distance	Effort
<i>Mini hurdle jumps</i>	2	10		
<i>Horizontal bounds</i>	2	10		
<i>Vertical jumps</i>	2	10		
Speed Work				
<i>Sprinting Technique Drills</i>	As coach prescribes.			
<i>Sprint Endurance</i>	3	Walk back recovery	200 meters	75% of Max Speed
<i>Sprint Endurance</i>	3	Walk back recovery	250 meters	75% of Max Speed
<i>Acceleration Work standing start</i>	4	3 minutes	30 meters	80% of Max Speed
Cool Down: <ul style="list-style-type: none"> • Static Stretching for upper and lower limbs • Foam roller releases for trunk, hips and lower limb's • If available vibration plate massage for trunk, hips and lower limb's 				

Recovery Methods

Currently the scientific literature is lacking when it comes to recovery methods in masters athletes. Older muscles have been shown to take on more damage when it comes to exercise, particular strength and power training ^[6,15, 37]. Furthermore, muscle damage is more likely to occur in connective tissue surrounding joints and muscles. Age related changes in connective tissue morphology may result in tissue stiffness, loss of elasticity, less pliability and less lubrication ^[37].

Masters athletes need to consider adopting sound recovery strategies if they wish to increase their recovery ability. Benefits of soundly structured recovery sessions include enhanced connective tissue lubrication and pliability, improved circulation and removal of metabolic waste products and improved flexibility and joint mobility. Therefore, to lessen these connective tissue changes, active cool-downs, stretching, hydrotherapy and massage should be prioritised in the masters athletes recovery session ^[37].

Outlined in table 3.0 below is a summary of recommended recovery strategies ^[37] for the strength and power orientated masters athlete:

Table 3.0: Recovery method strategies for the masters athlete.

	Nutrition	Muscular	Neurological
Guidelines	<ul style="list-style-type: none"> • Restore Protein and Carbohydrate post workout. • Restore muscle cell creatine levels. 	<ul style="list-style-type: none"> • Increase blood flow supply to fatigued muscles. • Reduce muscle micro trauma, & adhesions 	<ul style="list-style-type: none"> • Promote neuromuscular relaxation.
Activity	<ul style="list-style-type: none"> • Consume a protein/carbohydrate beverage immediately post workout. • Consume 5 grams of creatine monohydrate 	<ul style="list-style-type: none"> • Active recovery. • Hydrotherapy. • Massage or foam roller releases. • Compression garments 	<ul style="list-style-type: none"> • Active recovery. • Hydrotherapy. • PNF/Static Stretching. • Compression garments

Table adapted from ^[37].

As seen above, the strength and conditioning coach can easily implement effective recovery methods into their masters athlete training sessions, stretching and use of the foam roller are some examples of low cost options.

NUTRITION CONSIDERATIONS FOR THE MASTERS ATHLETE

Current nutritional guidelines for older adults ^[27] recommend older adults:

- Eat a wide variety of food groups
- Eat at least three meals a day
- Eat plenty of fruit and vegetables (including legumes)
- Eat plenty of cereals, breads and pasta
- Eat a diet low in saturated fat

- Use foods high in calcium
- Avoid foods high in salt
- Use sugars in moderation
- Limit the consumption of alcohol

These guidelines provide the strength and conditioning practitioner with some general nutritional guidelines. There is no mention of nutritional requirements for older adults who are highly active, and engaged in strength or power training. Important sporting nutritional guidelines are missing, such as the requirement for extra carbohydrate, protein, fluids and possibly sporting supplements ^[27].

To complement strength and power training, the masters athlete must ensure key nutrients are consumed in appropriate amounts. It has been shown older adults retain the ability to stimulate muscle and myofibrillar protein synthesis following a bout of resistance training well into older age ^[15,27,33].

Researchers recommend strength training older adults ensure their protein intake is above 0.8 g/kg/day, and more appropriately between 1.0 and 1.2 g/kg/day ^[37,15]. It has been shown that protein intakes below 0.5 g/kg/day affect muscle cell mRNA transcription possibly leading to sarcopenia ^[37]. The ability of a resistance training program to increase lean muscle mass in an older adult can be enhanced when carbohydrate and protein nutrition (supplements or food) are taken immediately after training. Research has shown that the early provision of protein, carbohydrates and fat post workout (10 grams of protein, 7 grams of carbohydrate and 3 grams of fat) lead to greater increases in muscle mass in a group of older adults, when compared to a 2 hour delay in consuming protein ^[37].

The research is quite sparse regarding carbohydrate intake recommendations for the strength and power oriented masters athlete. Masters athletes should consume adequate energy substrates to meet energy expenditure ^[37]. An acknowledged expert in the area Professor Peter Reaburn advocates that “carbohydrate intake for the masters athlete be similar to that of the general population, and consume at least 55% of their total energy intake from carbohydrate” ^[37]. More specifically if the masters athlete is engaged in 1-3 hours a day of moderate to high intensity activity (most likely in a strength and power based sport), the athlete should consume 7-10 grams of carbohydrate per kilo of body weight ^[37].

Finally, the role of supplementation in the masters athletes nutrition plan is worthy of consideration. For example, over 60% of the competitors in the 2004 world masters indoor championship indicated they were using some form of nutritional supplement ^[43]. Considering there is an age related decline in muscle cell fuel sources such as phosphocreatine ^[24] the use of supplements such as creatine monohydrate might be advocated. Currently, the literature shows the following supplements may be of use for a strength and power orientated masters athlete ^[37,46]:

- H.M.B (beta-hydroxy, beta-methyl butyrate). This study demonstrated that after 8 weeks of resistance training and supplementing with 3 grams per day of HMB, older adults tended to increase body mass and significantly reduced body fat compared to a placebo group who also completed 8 weeks of resistance training ^[37,48].
- Creatine Monohydrate. Three large randomised, double blind studies found supplementing with 5 grams a day of creatine monohydrate enhanced the resistance training induced gains in fat free mass and strength in older men and women ^[46].

Strength and conditioning practitioners should review their masters athletes eating plan and ensure they are meeting the standard healthy eating guidelines for an older adult. There may be a need to recommend an increase in the athletes protein and carbohydrate intake if training loads warrant it. Also consider supplementation with creatine monohydrate or HMB if muscle mass gains are the objective.

Conclusions

The evidence presented in this article has demonstrated that masters athletes remain highly trainable into older age. Improvement in sprint performance into older age can be obtained from the inclusion of mixed strength training programs. The current exercise guidelines for older adults are not appropriate for a competitive masters athlete. More complex training programs are necessary to bring about improvements in sporting performance. We suggest incorporating a 20 week mixed methods strength training program which may improve sprint performance and limit or reduce the age related declines in morphological and neuromuscular changes observed in the masters athlete. The information presented in this review may assist the strength and conditioning practitioner feel more comfortable in implementing a strength and conditioning program for a masters athlete.

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