Resistance exercise is medicine: Strength training in health promotion and rehabilitation

Brandon S Shaw_ Ina Shaw_ Gregory A Brown

The benefits of aerobic training in health promotion are well documented and this mode of exercise training continues to be the gold standard for health professionals when prescribing exercise programmes. However; resistance training has a wealth of unique benefits over those of aerobic training. It is these unique benefits that demonstrate the necessary role of resistance training in health promotion. The aim of this article is to demonstrate that resistance training is equally, and in some cases superior; to aerobic training in its health-promoting benefits, such as the increasing and/or maintenance of lean body mass and bone mineral density As such resistance training should be considered an integral component along with aerobic and flexibility training, in any exercise programme designed to promote health in all populations. However; it is essential for health professionals to understand and differentiate the subtypes of resistance training as these will have different impacts on sports performance, health promotion and rehabilitation.

Key words. • Health • Strength training • Weight training • Wellness

Submitted 5 May 2015; sent back for revisions 20 May 2015; accepted for publication following double- blind peer review 9 June 2015

Numerous studies have demonstrated the benefits of aerobic training in health promotion, and this mode of exercise training, usually in the form of walking, continues to be the gold standard for health professionals when prescribing exercise programmes for their clientele or patients (Westcott et al, 2009). Exercise prescriptions that focus solely on aerobic exercise are problematic in that resistance training has been shown to have a wealth of unique benefits over those of aerobic training (Shaw and Shaw, 2005; Phillips, 2007). In addition, adherence to exclusively aerobic exercise results in its own complications, such as the inability of aerobic training to reverse or halt the 4-6 pound (1.8-2.6kg) loss in lean body mass and concomitant 2–3% loss in resting metabolic rate per decade associated with normal ageing (Westcott et al, 2009).

However, as resistance training has until recently received little attention for its value in health promotion, the majority of literature on the health benefits following aerobic training has continued to make this mode of exercise the foremost focus of the physical activity guidelines governing the majority of major health organisations (Phillips and Winett, 2010). These endorsements continue to ensure that health professionals prescribe evidence-based programmes of mainly aerobic-type exercise.

This omission and the inferior status awarded to resistance training in such guidelines is also usually interpreted as a lack of importance of resistance training, especially when designing exercise programmes for health promotion and rehabilitation. Thus, the aim of this article is to:

- Demonstrate that resistance training is equally, and in some cases superior, to aerobic training in its health-promoting benefits
- Motivate health professionals to make use of resistance training, either alone or in combination with other modes of exercise.

Types of resistance training

It is typically believed that high loads and low repetitions are best to increase muscular strength, while lower loads and higher repetitions are best to increase muscle endurance. Phillips and Winett (2010) argue that it is this type of over-simplification of resistance training programme design that has depreciated resistance training as inferior to aerobic training and led to cardia-centric research in health prom otion. A large number of studies whose results formulate the basis for current resistance training programmes were conducted during the 1950s and 1960s further obscure the potential health benefits that could be attained following resistance training (Feigenbaum and Pollock, 1999).

In the past, in most cases, training designs that resulted in improvements in strength,

Brandon S Shaw,
Professor, Department of Sport and Movement Studies, Faculty of Health Sciences, University of Johannesburg, South Africa;
Ina Shaw,
Research manager, Monash University (South Africa Campus) and visiting full professor, Department of Sport and Movement Studies, Faculty of Health Sciences, University of Johannesburg, South Africa;
Gregory A Brown,
Professor, Department of Kinesiology and Sport Sciences, University of Nebraska, Kearney, USA.

Correspondence to: Brandon S Shaw
Email: brandons@uj.ac.za

muscle endurance and/or muscle hypertrophy spread quickly and became accepted globally. In contrast, programme designs that did not result in improvements in strength, muscle endurance and/or muscle hypertrophy were lost. This is problematic in that such designs may have proved effective in other contexts, for example, in the promotion of health. Further, at the infancy of resistance training studies, it was not easy to distinguish successful from unsuccessful training practices, primarily because it was difficult to clearly define the parameters of training. Precursors of resistance training also did not have at their disposal the sophisticated equipment that is available today (Stojiljkovic et al, 2013).

While resistance training (or weight training) is commonly called strength training, this term is a misnomer. Just as aerobic training can take the guise of long slow distance training, interval training and *fartlek* or 'speed play' training, resistance training can take the guise of strength training, power training, hypertrophy training, and/or muscular strength training (Baechle et al, 2008). As resistance training encompasses a myriad of subtypes of exercise, it is essential for health professionals to understand and differentiate between these subtypes as they have different impacts on sports performance, health promotion and rehabilitation, specifically (Baechle et al, 2008):

- Strength training requires training at a load of 85% or more of one repetition maximum (1RM) for 6 or less repetitions of 2–6 sets with rest periods of 2–5 minutes
- Power (single-effort) training requires training at a load of 80–90% 1RM performed at maximum speed for 1–2 repetitions of 3–5 sets with rest periods of 2–5 minutes
- Power (multiple-effort) training requires training at a load of 75–85% 1RM performed at maximum speed for 3–5 repetitions of 3–5 sets with rest periods of 2–5 minutes
- Hypertrophy training requires training at a load of 67–85% 1RM for 6–12 repetitions of 3–6 sets with rest periods of 30 seconds to 1.5 minutes
- Muscular endurance training requires resistance training at a load of 67% or less of 1RM for 12 or more repetitions of 2–3 sets with rest periods of 30 seconds or less.

It is critical that the health professional utilise the most recent evidence for effective resistance training in different populations (i.e. children, adults, the elderly) and/or different conditions (i.e. cardiopulmonary disease, cerebral palsy) when designing resistance training programmes.

However, it must be noted that numerous other factors can be manipulated within the resistance training programme design that could affect its effectiveness. These include, *inter alia*, time under tension, order of exercise, total training volume (Phillips and Winett, 2010), mode of resistance training (i.e. free weight *vs* variable resistance machines), and type of movement (i.e. isotonic, isokinetic or isometric) (Feigenbaum and Pollock, 1999).

LiTeraTure review

Until recently, there has been insufficient evidence to support the role of resistance training in health promotion or the prevention of disease (Hurley et al, 2011). While evidence now exists to support the role of resistance training in improving risk factors for specific diseases, no studies have provided a comprehensive assessment of resistance training, as compared to aerobic training, as a tool for health promotion.

However, what is clear about the essential and necessary role of resistance training in health promotion is that resistance training, compared with aerobic training, has the ability to decrease fat mass (especially abdominal and visceral fat) (Shaw et al, 2010a; Westcott, 2012), while simultaneously increasing lean body mass. This can occur even in the absence of changes in the dietary intake of total kilocalories, carbohydrates, proteins and fats (Shaw et al, 2008). The increase in lean body mass is especially important in the ever-increasing ageing population, which typically loses 4–6 pounds (1.8–2.6 kg) of lean body mass per decade (Westcott et al, 2009). Age-related progressive loss in lean body mass is also associated with a 2–3% loss in resting metabolic rate per decade, which results in a further increase in fat mass and dyslipidemia and reduced insulin sensitivity (Hunter et al, 2004).

Furthermore, resistance training, and not aerobic training, may increase bone mineral density by as much as 1–3% (Westcott et al, 2009). Resistance training has also been shown to improve cardiovascular health by:

- Reducing resting blood pressure (Shaw et al, 2010b)
- Improving lipoprotein-lipid profiles and/or dyslipidemia (i.e. decreasing low-density lipoprotein cholesterol)
- Decreasing triglycerides
- Increasing high-density lipoprotein cholesterol (Shaw et al, 2011; Williams et al, 2011)
- Reducing cardiovascular demands to physical activity (Kraemer et al, 2002a).

Resistance training should also form an integral part of any exercise guideline or programme for health promotion since this mode of training has the unique ability to improve muscle metabolic properties that may assist in the management and/or prevention of type 2 diabetes by decreasing visceral fat, reducing HbA_{1c} levels, increasing the density of glucose transporter type 4, and improving insulin sensitivity (Bweir et al, 2009; Westcott, 2012).

Resistance training is critical for reducing the risk of falls, especially in the elderly (Phillips, 2007), and has also been shown to reverse specific ageing factors in skeletal muscle (i.e. sarcopenia) and reduce the risk and severity of musculoskeletal injuries (Shaw and Shaw, 2014). In terms of musculoskeletal health promotion, resistance training has proven effective for reducing low back pain and easing discomfort, inflammation, muscle weakness and fatigue associated with arthritis and fibromyalgia (Hurley et al, 2011; Westcott, 2012).

Resistance training has further proved essential in improving and promoting (Hunter et al, 2004; Phillips, 2007; Westcott, 2012):

- Physical performance
- Movement control
- Walking speed
- Functional independence
- Cognitive abilities
- Self-esteem
- Participation in spontaneous physical activity.

However, although there is no evidence that resistance training can reverse any of the major biological or behavioural outcomes of diseases, such as cerebral palsy (Verschuren et al, 2011) or Alzheimer's disease, there is increasing evidence to suggest that the prevalence of these conditions is inversely associated with muscle mass and strength (Hurley et al, 2007), further presenting the need for resistance training in promoting mental health. While it has been found that increased cardiorespiratory fitness has been linked to a larger prefrontal cortex, resistance training may specifically help individuals who already have a condition known as mild cognitive impairment delay the onset of dementia (Liu-Ambrose and Donaldson, 2009). These researchers highlight an underappreciated aspect of resistance training in promoting overall physical and mental health.

a paradigm shifT

Much as the public health message regarding aerobic exercise has embraced simple acts of low-to-moderate intensity activity, there is a need for resistance exercise to be viewed as essential, effective, and easy to do.

Due to the ever-mounting evidence for the use and/or inclusion of resistance training in holistic exercise programmes, major health organisations, such as the American College of Sports Medicine (ACSM), have developed resistance training guidelines (ACSM, 2009). In this regard, the ACSM's minimum exercise guidelines recommends performing one set of 8–12 repetitions resistance of training exercises that train the major muscle groups twice weekly (hypertrophy-type training), in addition to 20 minutes of aerobic training thrice weekly. However, research on the efficacy of these recommendations has been minimal (Westcott et al, 2009) and, as stated earlier, since resistance training has received little attention, aerobic training has evidently continued to be the foremost focus in such guidelines.

Even when resistance training does not prove superior to that of aerobic training in promoting health, evidence for at least the equal inclusion of resistance training along with aerobic training in health promotion is becoming increasingly convincing (Pitsavos et al, 2009; Shaw et al, 2010b). Although it is supposed that an interference effect exists when combining aerobic and resistance exercises in athletes, but not in the general population (Shaw et al, 2009), increasing evidence is becoming available for the use of comprehensive programmes that combine aerobic training and resistance training. Concurrent training has previously been shown to reduce cardiovascular disease risk in previously sedentary individuals (Shaw et al, 2010b). However, further research is needed on the effect of concurrent training on health promotion since Wallace et al (1997) and Pierson et al (2001) did not find positive changes in lipoprotein lipids and blood pressure following their concurrent training programmes.

Having said this, it seems that the type of aerobic training performed with resistance training may result in different effects. For example, when resistance training is performed concurrently with running, but not cycling, significant decrements can be found in both hypertrophy and strength (Wilson et al, 2012).

When researching the effect of or designing such concurrent resistance and aerobic exercise training programmes, both researchers and health professionals need to be mindful that the time commitments for these concurrent programmes, whether performed on the same day or alternate days, should not exceed single modality resistance training or aerobic training programmes as this may limit the potential impact of health promotion and adherence rates to exercise programmes (Bosy-Westphal et al, 2004; Shaw et al, 2009). Interestingly, Heyward (1997) previously pointed out that individuals adhere to an exercise programme more readily when that programme is deemed enjoyable. The good news is that performing a resistance training session that meets the ACSM guidelines should only take 20–30 minutes (Phillips and Ziuraitis, 2004), which is similar to the recommended duration for aerobic exercise.

Further, it is critical to note that even though resistance training benefits can be safely obtained by most segments of the population (Hass et al, 2001), resistance training programmes and guidelines by their very nature and design have been developed separately to promote or restore health in:

- Healthy adults who are either sedentary or physically active (Kraemer et al, 2002b)
- Young people (Faigenbaum et al, 2009)
- The elderly (Willoughby, 2014)
- Patients with cardiopulmonary disease (Pollock et al, 2000).

In many educational and clinical contexts, resistance training is reputed to be made up of dangerous activities, such as weightlifting, especially in special populations such as children. However, there is no statistically convincing evidence that resistance training is particularly hazardous. In fact, the overwhelming impression from the surveys and literature is that resistance training is markedly safer than many other sports, certainly when supervised by qualified health professionals (Hamill, 1994).

When it comes to resistance training and health promotion, heavier is not better (Phillips and Winett, 2010) and the aim (i.e. improvement in blood pressure) and target population (youth *vs* elderly) of the resistance training programme must be clearly defined. As such, proper resistance training design that uses progressive overload, variation, and specificity is essential to maximise the health benefits of resistance training.

Conclusions

Given the relative lack of promotion of resistance training compared with aerobic training as a mainstream mode of exercise for health promotion, a central tenet of this article is that resistance training is equal, and in some cases superior, in its health-promoting and cardiopulmonary benefits to aerobic training. In recent years, this tenet has been gaining support among researchers and health professionals, with compelling evidence suggesting that resistance training should assume a position at least equal to that of aerobic training when designing exercise programmes and/or developing physical activity guidelines.

In view of this growing evidence base, it is hoped that health professionals will be further motivated to make use of resistance training, either alone or in combination with other modes of exercise. In addition, when designing resistance training programmes, health professionals should at all times consider the complexity of this mode of exercise and the population, client or patient for whom the programme is designed for. IJTR

Conflict of interest: none declared.

American College of Sports Medicine (2009) American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. *Med Sci Sports Exerc* **41**(3): 687–708. doi: 10.1249/MSS.0b013e3181915670

Baechle TR, Earle RW, Wathen D (2008) Resistance training. In: Baechle TR, Earle RW, eds. *Essentials of Strength Training and Conditioning*. 3rd edn. Human Kinetics, Champaign, IL: 381–412

Bosy-Westphal A, Reinecke U, Schlörke T, Illner K, Kutzner D, Heller M, Müller MJ (2004) Effect of organ and tissue masses on resting energy expenditure in underweight, normal weight and obese adults. *Int J Obes Relat Metab Disord* **28**(1): 72–9

Bweir S, Al-Jarrah M, Almalty AM, Maayah M, Smirnova IV, Novikova L, Stehno-Bittel L (2009) Resistance exercise training lowers HbA1c more than aerobic training in adults with type 2 diabetes. *Diabetol Metab Syndr* **1**: 27. doi: 10.1186/1758-5996-1-27

Faigenbaum AD, Kraemer WJ, Blimkie CJ et al (2009) Youth resistance training: updated position statement paper from the national strength and conditioning association. *J Strength Cond Res* **23**(5 Suppl): S60–79. doi: 10.1519/JSC.0b013e31819df407

Feigenbaum MS, Pollock ML (1999) Prescription of resistance training for health and disease. *Med Sci Sports Exerc* **31**(1): 38–45

Hamill BP (1994) Relative safety of weightlifting and weight training. *J Strength Cond Res* **8**(1): 53–7

Hass CJ, Feigenbaum MS, Franklin BA (2001) Prescription of resistance training for healthy populations. *Sports Med* **31**(14): 953–64

Heyward VH (1997) *Advanced Fitness Assessment and Exercise Prescription*. Human Kinetics, Champaign, IL

Hunter GR, McCarthy JP, Bamman MM (2004) Effects of resistance training on older adults. *Sports Med* **34**(5): 329–48

Hurley BF, Hanson ED, Sheaff AK (2011) Strength training as a countermeasure to aging muscle and chronic disease. *Sports Med* **41**(4): 289–306. doi: 10.2165/11585920-000000000-00000

Kraemer WJ, Ratamess NA, French DN (2002a) Resistance training for health and performance. *Curr Sports Med Rep* **1**(3): 165–71

Kraemer WJ, Adams K, Cafarelli E et al (2002b) American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. *Med Sci Sports Exerc* **34**(2): 364–80

Liu-Ambrose T, Donaldson MG (2009) Exercise and cognition in older adults: Is there a role for resistance training programmes? *Br J Sports Med* **43**(1): 25–7. doi: 10.1136/bjsm.2008.055616

Phillips SM (2007) Resistance exercise: good for more than just Grandma and Grandpa's muscles. *Appl Physiol Nutr Metab* **32**(6): 1198–205

Phillips SM, Winett RA (2010) Uncomplicated resistance training and health-related outcomes: Evidence for a public health mandate. *Curr Sports Med Rep* **9**(4): 208–13. doi: 10.1249/JSR.0b013e3181e7da73

Phillips WT, Ziuraitis JR (2004) Energy cost of single-set resistance training in older adults. *J Strength Cond Res* **18**(3): 606–9

Pierson LM, Herbert WG, Norton HJ et al (2001) Effects of combined aerobic and resistance training versus aerobic training alone in cardiac rehabilitation. *J Cardiopulm Rehabil* **21**(2): 101–10

Pitsavos C, Panagiotakos DB, Tambalis KD et al (2009) Resistance exercise plus to aerobic activities is associated with better lipids' profile among healthy individuals: the ATTICA study. *QJM* **102**(9): 609–16. doi: 10.1093/qjmed/hcp083

Pollock ML, Franklin BA, Balady GJ et al (2000) Resistance exercise in individuals with and without cardiovascular disease: Benefits, rationale, safety, and prescription an advisory from the Committee on Exercise, Rehabilitation, and Prevention, Council on Clinical Cardiology, American Heart Association. *Circulation* **101**: 828–33. doi: 10.1161/01.CIR.101.7.828

Shaw BS, Shaw I (2005) Effect of resistance training on cardiorespiratory endurance and coronary artery disease risk: Cardiovascular topics. *Cardiovasc J S Afr* **16**(5): 200–4

Shaw BS, Shaw I, Brown GA (2008) Self-reported dietary intake following endurance, resistance and concurrent endurance and resistance training. *J Sports Sci Med* **7**(2): 255–9.

Shaw BS, Shaw I, Brown GA (2009) Comparison of resistance and concurrent resistance and endurance training regimes in the development of strength. *J Strength Cond Res* **23**(9): 2507–14. doi: 10.1519/JSC.0b013e3181bc191e

Shaw BS, Shaw I, Mamen A (2010a) Contrasting effects in anthropometric measures of total fatness and abdominal fat mass following endurance and concurrent endurance and resistance training. *J Sports Med Phys Fitness* **50**(2): 207–13

Shaw I, Shaw BS, Brown GA, Cilliers JF (2010b) Concurrent resistance and aerobic training as protection against heart disease. *Cardiovasc J Afr* **21**(4): 196–9

Shaw BS, Shaw I, Goon DT (2011) Resistance training and blood lipid regulation: A review of the evidence. *Med Sport* **64**(4): 511–21

Shaw I, Shaw BS (2014) Resistance training and the prevention of sports injuries. In: Hopkins G, ed. *Sports Injuries: Prevention, Management and Risk Factors*. Nova Science, New York: 123–36

Stojiljkovic N, Ignjatovic A, Savic Z, Markovic, Z, Milanovic S (2013) History of resistance training. *Activities in Physical Education and Sport* **3**(1): 135–8

Key poInTs

- Findings unequivocally indicate that resistance training is safe for most segments of the population, especially when supervised by qualified health professionals
- Health professionals must utilise the most recent evidence for effective resistance training in different populations and/or different conditions when designing resistance training programmes
- Resistance training is equally, and in some cases superior, to aerobic training in its health-promoting benefits
- Health professionals should make use of resistance training, either alone or in combination with other modes of aerobic exercise to maximise the unique benefits of each for their patients.

Verschuren O, Ada L, Maltais DB, Gorter JW, Scianni A, Ketelaar M (2011) Muscle strengthening in children and adolescents with spastic cerebral palsy: Considerations for future resistance training protocols. *Phys Ther* **91**(7): 1130–9. doi: 10.2522/ptj.20100356

Wallace MB, Mills BD, Browning CL (1997) Effects of cross-training on markers of insulin resistance/hyperinsulinemia. *Med Sci Sports Exerc* **29**(9): 1170–5

Westcott WL, Winett RA, Annesi JJ, Wojcik JR, Anderson ES, Madden PJ (2009) Prescribing physical activity: Applying the ACSM protocols for exercise type, intensity, and duration across 3 training frequencies. *Phys Sportsmed* **37**(2): 51–8. doi: 10.3810/psm.2009.06.1709

Westcott WL (2012) Resistance training is medicine: Effects of strength training on health. *Curr Sports Med Rep* **11**(4): 209–16. doi: 10.1249/JSR.0b013e31825dabb8

Williams AD, Almond J, Ahuja KD, Beard DC, Robertson IK, Ball MJ (2011) Cardiovascular and metabolic effects of community based resistance training in an older population. *J Sci Med Sport* **14**(4): 331–7. doi: 10.1016/j.jsams.2011.02.011

Willoughby DS (2014) Resistance training and the older adult. *American College of Sports Medicine Current Comment.* http://acsm.org/docs/current-comments/resistancetrainingandtheoa.pdf (accessed 1 July 2015)

Wilson JM, Marin PJ, Rhea MR, Wilson SM, Loenneke JP, Anderson JC (2012) Concurrent training: A meta-analysis examining interference of aerobic and resistance exercises. *J Strength Cond Res* **26**(8): 2293–307. doi: 10.1519/JSC.0b013e31823a3e2d