The Coming of Age of Resistance Exercise as a Primary Form of Exercise for Health

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Apply it!

By reading this article, the health and fitness professional will learn:

- Physical activity guidelines emphasize the performance of aerobic exercise for health and often indicate that resistance exercise can be beneficial; however, emerging evidence shows that resistance exercise is often as effective as aerobic for many aspects of health.
- Resistance exercise participation can benefit several health aspects: cardiorespiratory health, vascular health, muscle oxidative capacity, mental health, muscle hypertrophy, strength, and power.
- To support clients in sticking to their program, use strategies like monitoring (you and your client keeping track of how much resistance exercise they are doing), action planning (scheduling when, where, and how they will do their resistance exercise), and highlighting the health and emotional benefits of resistance exercise that are relevant to your client.

Key words: Muscle strength, Muscle power, Diabetes, Aerobic exercise, Sarcopenia

INTRODUCTION

Physical activity (PA) guidelines emphasize aerobic exercise (AE) as the primary form of exercise leading to improved health. Many guidelines also state that some form of resistance exercise (RE) is beneficial. The body of evidence supporting the health benefits of AE has a far greater evidence base than those for RE; however, we propose that RE is emerging as a mode of exercise with greater similarity, rather than disparity, in health benefits as those associated with AE. Naturally, some phenotypic characteristics will remain almost exclusive to AE, including cardiorespiratory fitness (CRF), while muscle strength and power are developed with RE (1). Here we propose that PA guidelines need to adopt and place greater emphasis on the stance that aerobic and REs are uniquely beneficial for some health outcomes with advancing age, where muscle strength and power may become increasingly important.

People know that exercise is good for us; however, it may be more accurate to say people equate that axiom with AE is good for us. Much of our knowledge of the benefits of AE training comes from longitudinal observations as part of Dr. Kenneth Cooper's legacy and his coining of the term aerobics (2). A landmark study came in 1989 with a publication led by Dr. Steven Blair (3). The conclusion from that article was that greater fitness (aerobic capacity) delayed mortality via reductions in cardiovascular disease and cancer. The same publication (3) and subsequent articles (4–6), along with data from numerous sources, have cemented AE as a cornerstone part of PA guidelines. In 2016, Ross et al. (7) made a case for CRF as a clinically relevant vital sign stating that "CRF is a potentially stronger predictor of mortality than established risk factors such as smoking, hypertension, high cholesterol, and type 2 diabetes mellitus." Such is the power of this evidence (3–6) that 150 minutes of moderate to vigorous aerobic PA is inculcated in global PA guidelines. We note, however, that in many guidelines, there is a recommendation for people to pursue "muscle-strengthening activities," which we view as being most easily manifested by

engaging in RE training twice weekly (https://health.gov/our-work/nutrition-physical-activity/physical-activity-guidelines/current-guidelines and https://csepguidelines.ca/). Some have referred to the muscle-strengthening portion of the PA guidelines as being "the forgotten" (8) part of the guidelines. We acknowledge, however, that the most recent U.S. PA guidelines and the 2020 World Health Organization (WHO) PA guidelines (https://www.who.int/publications/i/item/9789240015128) do include statements regarding both AE and RE as being beneficial. Yet, fewer people engage in RE compared to AE, although self-report may not be wholly reflective of actual participation (9,10). Interestingly, we are now beginning to understand that RE training is, in some instances, as effective as AE in mitigating the progression of certain chronic diseases, delaying mortality and perhaps, especially with advancing age, more potent in preventing functional declines (11,12).

It is becoming clearer that AE and RE participation is required for optimal health. Critically, it is not just AE that imparts health benefits; RE likely has just as many and some unique health benefits, but the reverse is also true. Our position is that the health benefits of regular engagement in RE are being increasingly recognized and that RE is not merely the exclusive domain of power- or strength-training athletes as a way to be stronger and more muscular. By contrast, RE is a form of exercise that leads to good health and may be requisite for healthy aging.

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Here we provide a brief overview of the somewhat underrecognized, underemphasized, and possibly underappreciated benefits of RE, not as a substitute for AE (although it might be argued it could serve in that capacity in some instances) but as an adjunctive and necessary form of exercise. We also note that participation rates in RE are low and, importantly, lower than AE (https://www.cdc.gov/nchs/fastats/exercise.htm); thus, we speculate on what might be the reason for this and what could be done to lower barriers to participation in RE. Importantly, we note that a key message that may be missing or currently underpromoted in assisting people in adopting RE as a form of exercise is the knowledge of the associated health benefits.

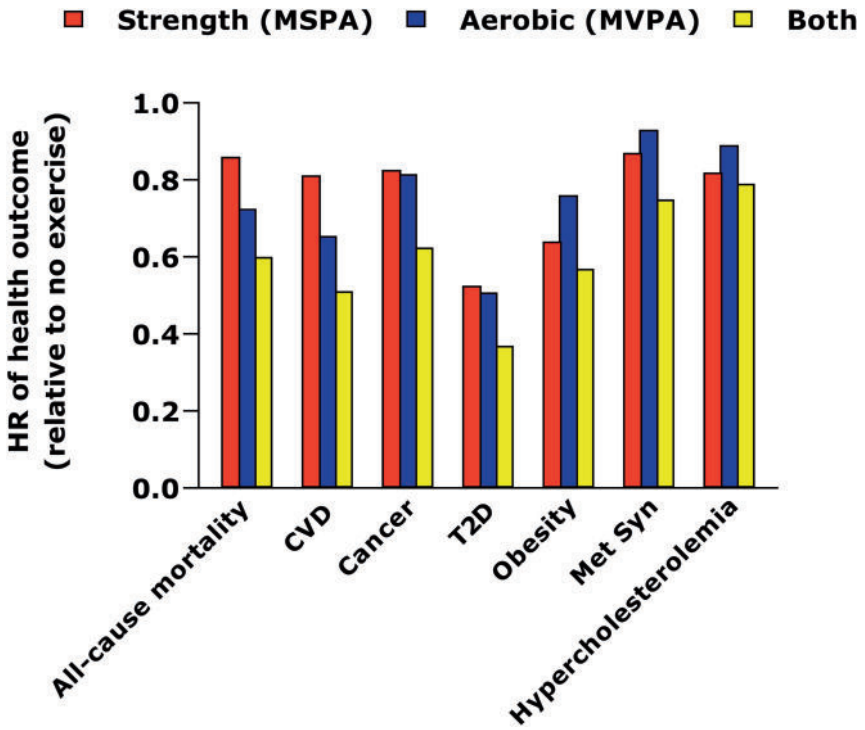
THE HEALTH BENEFITS OF RE

Numerous analyses show that RE can impart several health benefits, including improving the prognosis for type 2 diabetes (T2D) (13). This effect is not different, at least insofar as lowering glycated hemoglobin (HbA1c) concentration, from that seen with AE (14). Interestingly, it may be that strength gains mediate this relationship such that greater improvements in muscular strength lead to greater reductions in HbA1c (14). There also is evidence to suggest that RE training reduces the incidence of T2D (15). Given the global prevalence and anticipated increase in the number of cases of T2D, it would seem that adding RE training as a potentially viable option to address this costly disease would be prudent.

Survivorship rates in certain cancers have improved dramatically, largely thanks to screening, effective treatments, and surgical procedures. We view cancer survivors as the next generation of chronic disease patients who, like cardiac-rehab patients before them, should be considered candidates for rehabilitation peri-treatment to improve their health-related quality of life. Like AE, RE also has beneficial effects on cancer patients with varying types of cancer. There is evidence that RE is safe and feasible in breast cancer (16,17), colorectal cancer (18), and prostate cancer (19). It also may be that participation in RE is preventive against cancer (20). One review found long-lasting effects of the combination of AE and RE on cancer-related global fatigue and treatment side effects (20). These authors (21) highlighted the overlapping nature of these effects and concluded, "exercise interventions have lasting clinical benefits in ameliorating adjuvant therapy side effects, which negatively impact physical fitness and mental well-being."

A growing body of work also shows that RE reduces cancer- and cardiovascular disease–related and all-cause mortality risk (20,22,23). Interestingly, RE independently adds to AE in lowering mortality risk (24), suggesting that the two forms of exercise may confer health benefits through distinct mechanisms in different or similar pathways. To illustrate the extent of risk reduction, Figure 1 provides crude hazard ratios (how often death occurs in one group performing the exercise compared with how often it happens in another group performing no exercise over time) for various health outcomes for people engaging in either AE, RE, or both. The data are from an excellent, detailed review (1) of the independent and combined effects of AE and

Figure 1. Crude hazard ratio (HR, defined as how often the hazard, death, occurs in one group performing the exercise compared with how often it happens in another group performing no exercise over time; lower values indicate reductions in mortality) when adhering to different components of the physical activity guidelines (moderate to vigorous physical activity [MVPA] and/or moderate strengthening physical activity [MSPA]) compared with meeting neither guideline (*i.e.*, no exercise and thus HR = 1.0) with various health outcomes from prospective studies. CVD, cardiovascular disease; T2D, type 2 diabetes; Met Syn, metabolic syndrome. Data are redrawn from Brellenthin et al. (1) with permission.



RE on numerous outcomes to answer the question, "Aerobic or muscle-strengthening physical activity: which is better for health?" Figure 1 clearly illustrates that mortality is lower in persons who engage in RE and AE alone but is further lowered in those who engage in both AE and RE. As Brellenthin et al. (1) point out, "the prospective associations between MVPA [moderate-to-vigorous PA] and MSPA [muscle-strengthening PA] and mortality outcomes have been largely consistent … *meeting both guidelines* [italics added] has been associated consistently with the largest risk reductions for mortality."

AGING

Our global population is aging rapidly, and the number of people at risk for health problems is growing in parallel. Many countries have no strategies to address an aging population that may well spend time with disabling illnesses. A laudable goal would be to add even a few years to *healthy* life expectancy, which could save billions of dollars if applied at a population level. Critically, the addition of RE among older adults who already meet the AE guidelines results in a lower risk of sarcopenia-related symptoms (25).

A reduced functional capacity with aging is related to sarcopenia, leading to a lower quality of life, increased risk for falls, and hospitalization. RE is the most effective method to attenuate these reductions in function with aging, and there are multiple lines of evidence supporting this (11,12,26). Aging is an area where RE has been shown to have remarkable benefits in terms of mitigating declines in muscle strength and power (11,12) and delaying the transition to frailty (26). It may be in aging where the inclusion of RE, in addition to AE, would be highly beneficial, possibly essential, to maintain functional independence and mitigate chronic health disease risk (11,12,26). The loss of muscle power with aging may be particularly important, and several reviews have shown improvements in muscle power in older adults using exercises focused on higher concentric velocities (27–29). Higher velocity training also results in muscle hypertrophy (29) and improved performance of activities of daily living and is associated with changes in relevant health outcomes, including improved cognitive function (28). Given the chronic disease risk lowering with higher CRF (7) and the antifrailty effects of RE (11,12, 26), it would seem obvious that a combination of these two forms of exercise be included as a prescription for successful aging. Additionally, it is worth noting that there is an exceptionally good safety record for RE in older persons with very few adverse events (30–32).

An underdescribed benefit unique to engagement in RE is a spontaneous increase in PA, especially in older adults (33–36). For instance, after 10 weeks of resistance training in 100 frail nursing home residents (aged 72 to 98 years), strength increased by 113%, gait velocity increased by 12%, and stair-climbing power increased by 28% (33). These improvements were accompanied by a 51% increase in daily PA, demonstrating that RE alters PA behaviors in older adults. Similarly, a group of postmenopausal women (aged 50 to 70 years) who performed RE for 1 year showed increased bone mineral density, muscle mass, strength, balance, and a 27% increase in daily PA (34). Importantly, in this study, 1 year without RE resulted in a 25% reduction in PA in the control group; thus, the net effect of RE is substantial. Another group found that 26 weeks of resistance training in older adults (61 to 77 years) resulted in increased strength, fat-free mass, resting energy expenditure, and a 12% increase in free-living energy expenditure (35). Most recently, in the Resist Diabetes study, 170 overweight/obese, sedentary, or minimally active middle-aged and older adults (50 to 69 years) participated in a 15-month, twice-weekly resistance training program (36). PA levels increased during months 3 through 9 and were maintained during months 9 through 15. For some populations, such as older adults, low-active adults, and those with obesity, resistance training may be a gateway to increased non-RE associated PA. This "spillover" effect could result from increased strength, power, or muscle mass; decreased fat mass; or improvements in psychosocial factors such as self-efficacy or confidence and could explain some of the overlapping benefits of RE and AE training.

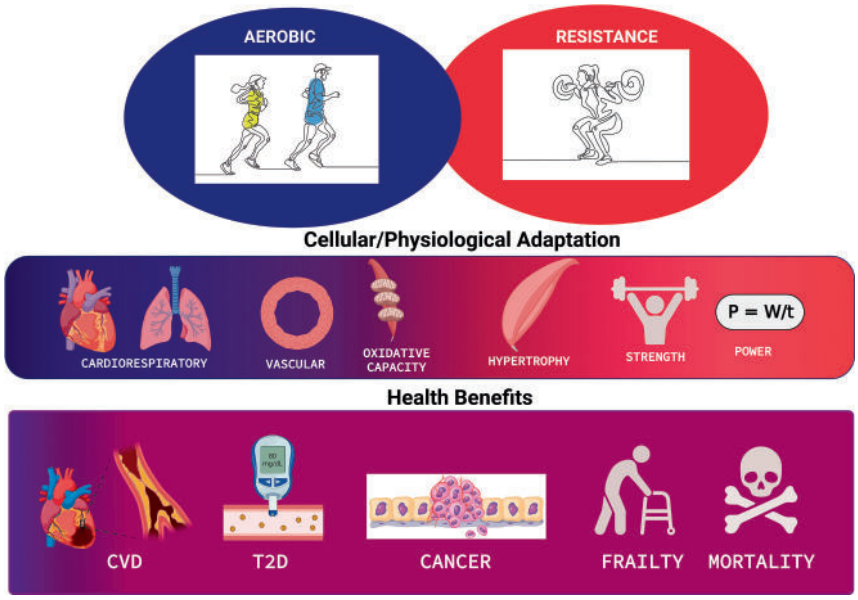
THE DOGMATIC CELLULAR ADAPTATION PARADIGM

Many textbooks and review articles (37) paint AE and RE at opposite ends of a dichotomous spectrum regarding the physiological adaptations they manifest. Indeed, improvements in aerobic fitness arise almost exclusively with increased AE. By contrast, acquiring muscular strength and power would belong to RE. We agree that cellular-level adaptations, as they are classically taught, are distinct between AE and RE; however, we propose that a growing number of reports show that the health benefits of RE have more in common with, versus being distinct from, AE (Figure 2). As Figure 2 schematically indicates, AE and RE imbue phenotypic qualities that are, in some cases, the exclusive domain of those exercise subtypes. Essentially, CRF predominantly comes from AE, and muscle strength and power will come from RE. However, as is also noted in Figure 2, there is likely much more in common, at least from a health perspective, between RE and AE, and the forms of exercise are additive or synergistic in their benefits (Figure 1). Given what we know of habitual participation in AE training or RE training, let alone both (as most PA or movement guidelines recommend), most people would likely need to adopt RE training as a form of exercise rather than AE training.

SUPPORTING RE PARTICIPATION

Based on substantial evidence, we have made the case that participation in RE results in numerous health benefits. However, participation in RE is low, even compared with AE participation rates (38). Although approximately 50% of people meet the aerobic PA guidelines of 150 minutes of moderate to vigorous PA per week, less than a third of the population participates in regular RE twice per week (38). This discrepancy in participation signals that there are unique barriers to participating in RE. Particularly, the increased time constraints, the need for access to equipment and facilities, and the perceived complexity of RE may explain these especially low participation rates. The American College of Sports Medicine and other national and international guidelines recommend participating in strength training twice weekly. However, setting the guidelines as the starting goal is likely inappropriate, given the challenges of beginning and sustaining RE participation. Discussions with clients

Figure 2. A schematic representation of physiological effects from participation in aerobic exercise (AE) or resistance exercise (RE) and the possible physiological systems and subcellular processes they affect: cardiorespiratory health, vascular health, muscle oxidative capacity, mental health, muscle hypertrophy, muscle strength, and power. The bottom of the figure shows that participation in AE and RE and their health effects should be considered to have more in common than disparate. These outcomes include cardiovascular disease, type 2 diabetes, cancer, frailty, and mortality (see Figure 1). Created with BioRender.com.



new to RE could benefit from 1) focusing on the minimum prescription to achieve health and fitness benefits and 2) behavioral strategies to support their long-term participation (39). Notably, the 2018 U.S. PA guidelines emphasize that a single set of 8 to 12 repetitions for all major muscle groups twice weekly is a minimally effective dose of RE, particularly for those who are previously untrained.

Guidelines for the minimum prescription needed for RE to induce health and fitness adaptations remain to be established, but evidence for this minimum threshold is mounting. A recent meta-analysis of 16 prospective observational studies with at least 2 years of follow-up demonstrated that any RE is associated with a decrease in all-cause mortality compared with no RE (40). Encouragingly, the optimal dose for lowering the risk of all-cause mortality and cases of cardiovascular disease, cancer, and diabetes was shown to be as low as 30 to 60 minutes/week, with diminishing returns over greater time commitments (40); however, other analyses have not observed this relationship and instead found a U-shaped association and mortality risk with RE participation (22,23). Improving strength is essential to lowering mortality and disease risk (22,23,40) and can be achieved using minimal-dose resistance programs (41). These programs can include prescribing as little as single sets or a frequency of once per week, a range of loads (≥30% 1RM), a range of reps per set, and the use of body weight or resistance bands (41). Although progressive overload is important to target long term, there are benefits to doing the bare minimum in frequency, load, time, type, and volume. To our knowledge, most of these studies have participants complete sets near or to momentary muscle failure. Thus, the caveat is that higher effort is required for these minimal-dose resistance programs to be effective.

A national survey of 1,338 Canadian adults identified a large intention–behavior gap in participating in RE (38). Of those who want to undertake RE, only 42% act on their intentions (38). These findings suggest that strategies similarly used to improve AE participation, like monitoring and action planning, may be needed to address this intention–behavior gap (38,39). Rhodes and Lithopoulos (38) also highlighted RE intervention targets unique from AE promotion. As we have already detailed, the expected benefits of RE are often underemphasized or underappreciated compared with AE. Affective attitude (expected pleasure or enjoyment) is a critical predictor of AE participation, but most already know that AE is good for their health (instrumental attitudes). For RE, both affective and instrumental attitudes were equal predictors of participation. In other words, discussing both the emotional and the health benefits of RE may be needed to form intentions to participate. There also are gender-based differences in approaches (38). For example, building confidence in doing RE is an important target for older women but not necessarily men. By contrast, identity as someone who is a resistance exerciser is an important predictor of participation for younger/middle-aged men but has negligible importance for older women.

WHERE TO NEXT?

We are beginning to understand what regular participation in RE alone and combined with AE can do for health. However, evidence to date suggests that as a form of exercise, RE shares more in common with AE from a health-promoting standpoint than we may have realized (Figures 1 and 2). On this basis, we propose that PA guidelines make clear that there are situations where aerobic or RE are equally beneficial from a health standpoint. We also suggest that the same guidelines emphasize that some aspects of health, especially in older persons, are better served by engaging in RE (42).

As observed in the high-intensity interval training AE literature, designing minimal-dose programs that address barriers of time, complexity, and access to equipment is often still not enough to change behavior. Further, performing maximal or near-maximal efforts is unappealing to many. Evidence for the minimum effort required to produce health and fitness adaptations is needed. Nonetheless, adding alternative, lower-effort muscle-strengthening activities (*e.g.*, tai chi, hiking, and sports) to a program or performing RE in group settings may help garner interest in muscle-strengthening activities (39). It also is critical to note that RE activities can take many forms, requiring minimal or no cost. Hence, although machines or free weights can apply resistance, people also can use elastic exercise bands and dumbbells or their own body weight (*e.g.*, step-ups, pull-ups, push-ups, bodyweight squats). Many far more detailed and varied RE programs are outlined and discussed in detail elsewhere (43).

Larger and longer trials with RE are needed, with varying "doses," to make more definitive conclusions regarding health effects and mortality. Until these data exist, we would still advocate, based on current evidence, for a greater emphasis on engagement in RE and AE for optimal health.

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BRIDGING THE GAP

Resistance training is being shown to have health benefits that are similar to those associated with the performance of AE. We consider the performance of RE as a *de rigeur* activity for optimal health in aging. Recent work has shown that RE and AE are additive in reducing premature mortality.