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Editorial

Is the scientific evidence available on exercise training adequate for advising the population on lifelong exercising habits?

Claudio Gil S. Araujo

Universidade Gama Filho, Clínica de Medicina do Exercício – CLINIMEX, Rio de Janeiro, Brazil

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In recent years, interest in exercise training for both healthy and unhealthy individuals has grown rapidly. Large cohort studies (4) and randomized clinical trials have created widespread recognition that regular physical exercise has health benefits for both men and women of all age-groups (15). Nowadays, it is well-known that a healthy lifestyle includes regular physical exercise, with some variation in type, frequency, intensity and duration, according to age and individual goals (11). As a rule, almost all the benefits of exercise seem to follow a quasi-linear dose-response pattern (6), with the most favorable results obtained by changing from a sedentary habitus to a somewhat active lifestyle. Notwithstanding, some additional benefits can be obtained by exercising longer, harder and more often, with vigorous exercise being better than light or moderately intense exercise (2). In reality, recent European and American institutional guidelines (11, 14) have suggested that, per week, 75 minutes of vigorous exercise are equivalent to 150 minutes of light to moderate exercise.

The relevance of regular physical exercise to health has resulted in more academic research on the relationship between these two, and, consequently, more articles on this topic. Searching Medline, the most famous medical literature database, with over 20 million citations for biomedical literature, reveals that about 4% of these papers include the expressions physical activity OR physical exercise OR sports in their titles or abstracts. This increase in the rate of annual publications on exercise seems to be higher than the same rate for other areas of biomedical knowledge. To address this hypothesis, we have compared the number of citations, within different time limits, for physical activity OR physical exercise OR sports versus hepatitis, an old and classical disease. Using this approach, it is possible to differentiate any real increase from the increase that might be caused by covering a larger number of journals. With no time limit imposed, there is less than a 20% difference between the number of citations for both conditions – exercise (197,800) versus hepatitis (167,000). However, in recent years, the number of exercise citations has increased more quickly than the number of hepatitis citations, bringing the difference between the two to over 50%. While exercise citations grew significantly, from a mean of 750/year during the 2001-2005 period, to over 1,100/year in the last two-year period, for published papers in Medline-indexed journals, the equivalent figures for hepatitis are more or less stable along the last 10 years, ranging from 620 to 720/year (see figure 1).

Another reliable source of high-level research activities is the Clinical Trials Registry (www.clinicaltrials.gov). Formal registration in this international body has been endorsed by the International Council of Medical Journal Editors and made mandatory by a growing number of clinical journals for all original papers submitted for publication. In this registry, there are currently (March 2011) more than 100,000 trials (the large majority of them randomized) from researchers located in 174 countries. Navigating this website, it is possible to observe the clinical research trends in a given area, since the site incorporates not only finalized, but also ongoing and even many just-proposed and about-to-start, randomized clinical trials. Searching exercise training and limiting for interventional studies and those considering only adults

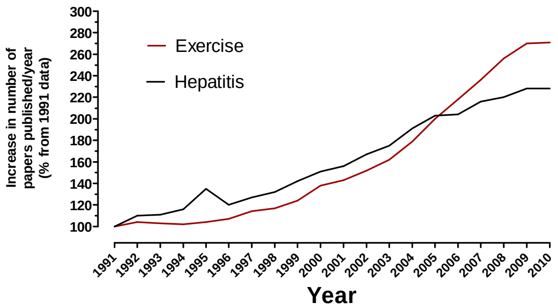

Figure 1: 1991-2010 trends in number of papers indexed in Medline with *exercise* and *hepatitis* expressions (values are normalized as 100% of 1991 data).

Corresponding author:
Claudio Gil S Araujo: Universidade Gama Filho/Clínica de Medicina do Exercício - CLINIMEX CLINIMEX - Clínica de Medicina do Exercício • Rua Siqueira Campos, 93/101 • 22031-070, Rio de Janeiro - RJ – Brasil • Phone: 21-2256-7183 • Fax: 21-2549-4295 • Email: cgaraujo@iis.com.br

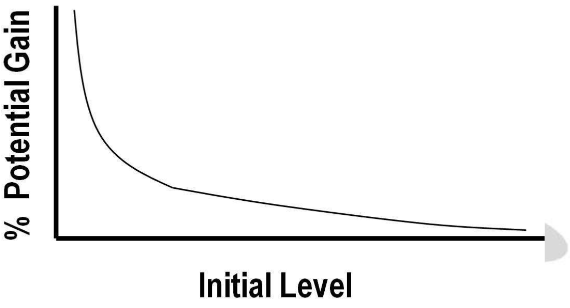

Figure 2: Trainability potential.

or senior individuals, a total of 947 trials were identified. Following the order presented by the search engine, a sample of 5% (47 trials) was further revised for more detailed examination.

The 47 randomized trials selected involve a variety of clinical conditions, most often but not only cardiovascular diseases, and were conducted in 15 different countries. The median intervention training duration was 3 months, ranging from just a few sessions (about one week) to 3 years. Interestingly, only about 10% lasted one year (4 studies) or more (one 3-year study), with the majority reporting 3-month or 12-week periods. Having collected all this reliable and relevant data about the status of scientific knowledge on exercise-related topics, we could try to contextualize it to serve our purpose of encouraging as many people as possible to be physically active.

It has long been well-known that adaptation or trainability is related to both initial level and duration of stimulus exposure. In other words, an individual who performs at a low level for a given variable or attribute will tend to obtain faster and larger improvement with training than another individual who, when beginning training, already performs at a higher level. In the same way, most benefits or gain in performance tend to occur during the very first stages of training, with very modest or even no improvement if stimulus is kept constant forever (figure 2 for a typical trainability response curve).

While it is very reasonable to consider logistics and economics when pursuing longer interventions in research settings, it is, at least, intriguing to consider

Table 1: A proposal of classification of interventional studies by duration.

Classification	Duration
Very short-term	< 4 weeks
Short-term	4 to 12 weeks
Medium-term	3 to 6 months
Long-term	6 to 60 months
Very long-term	5 to 30 years

how this information can be used with patients in real life. Let us suppose that an exercise specialist is required to advise a 40-year old sedentary man on how to start and incorporate a strength training program into his personal routine. Searching the literature, the specialist finds a well-designed randomized trial in which a sample of healthy, sedentary adults volunteered for two regimens of an 8-week strength training program, named Y and Z.

Hypothetically, at the end of the intervention, the results showed a significantly larger gain – 18% vs 13%, respectively – in 1-RM (one maximum repetition) of a biceps curl movement. At first sight, the Y training regimen is better and should be recommended. However, this study, as carried out, does not tell us what would happen if the same individuals, rather than performing Y and Z for eight weeks, incorporated these regimens into their daily routines and continued to train for life. If both training regimens are continued for years and years, will program Y start to generate more injuries or show less subject adherence? Will program Y continue to show larger strength gains? Unfortunately, we do not have any scientific evidence to answer these very relevant questions and others similar to them, but considering the concept of trainability, similar results could be expected in the long-term, since the possibility of improvement is inversely related to initial level of improvement (those who experienced more benefits after week 8 would perform at a higher level after the next 8 weeks and so forth). Returning to our hypothetical case, and hoping that the trainer's client continues to perform strength training for the rest of his life, maybe 40 years, are the small differences seen between programs Y and Z during an 8-week period (less than 1% of a 40-year period) relevant when prescribing strength training for life? Most likely, no!

In other words, the vast majority of exercise training studies are too short, compared to human life expectancy (close to 80 years) or years of adult life (40 to 50 years), and too few studies are conducted after 10- to 40-year follow-up periods (3, 5, 9, 12, 13), to be able to generate precise or relevant information that answers long-term questions. In fact, the 8 or 12-week periods over which interventional exercise training studies are conducted correspond to about 0.1% of the potentially active lifespan of a human being! So, if we really want to encourage people to incorporate comprehensive exercise – aerobic, muscular strength/power, flexibility, coordination and balance – for health purposes into their daily lives, as has been recommended (2, 6, 11, 14), and decrease the chance of presenting exercise-related injuries, long-term interventional exercise training studies are urgently needed, even if it is less feasible to control variables in such studies and randomized trials are unviable. For practical reasons, in table 1, a list of expressions related to intervention duration is proposed.

It is also important to consider the aging process when thinking about exercise performance and training. While it is widely recognized that, even for the oldest individuals, some trainability is preserved, it is also clear that aging per se tends to impair maximal performance of physical fitness activities (1, 16, 17). However, when previously sedentary middle-aged individuals start regular and vigorous physical exercise training regimens, quite often, their performance not only improves, but also becomes better than or superior to that of young, sedentary adults (3). On the other hand, several studies of master athletes have shown that the maximal performance of those physically active throughout their lives is inferior to that achieved by young athletes (7, 8). Nevertheless, it is quite frustrating to recognize that there are no long-term intervention exercise training studies available that have identified the best protocols for maintain high levels of physical fitness throughout life. As a matter of fact, from a lifelong perspective, the most desirable scenario is to maintain physical fitness as much as possible – aerobicism, flexibility, strength/power and body composition – in order to diminish the effects of aging (3, 10), but, again, we do not yet know which exercise stimuli most effectively achieve this goal.

In summary, while appropriate randomized clinical trials are certainly needed to carefully control most or all of the intervening or confounding variables, it is likely time to consider the potential of less-controlled long-term intervention studies on exercise training, especially when more practical information is surely demanded by health professionals and society. Adding to and balancing the information derived from these two approaches will yield the best advice on how to make more people physically active.

REFERENCES

1. Araujo CGS. Flexibility assessment: normative values for flexitest from 5 to 91 years of age. *Arq Bras Cardiol* 2008; 90: 257-263.
2. Artinian NT, Fletcher GF, Mozaffarian D, Kris-Etherton P, Van Horn L, Lichtenstein AH, Kumanyika S, Kraus WE, Fleg JL, Redeker NS, Meininger JC, Banks J, Stuart-Shor EM, Fletcher BJ, Miller TD, Hughes S, Braun LT, Kopin LA, Berra K, Hayman LL, Ewing LJ, Ades PA, Durstine JL, Houston-Miller N, and Burke LE. Interventions to promote physical activity and dietary lifestyle changes for cardiovascular risk factor reduction in adults: a scientific statement from the American Heart Association. *Circulation* 2010; 122: 406-441.
3. Aspenes ST, Nauman J, Nilsen TI, Vatten L, and Wisloff U. Physical activity as a long term predictor of peak oxygen uptake: the HUNT-study. *Med Sci Sports Exerc* 2011 (ahead of press).
4. Aspenes ST, Nilsen TI, Skaug EA, Bertheussen GF, Ellingsen O, Vatten L, and Wisloff U. Peak oxygen uptake and cardiovascular risk factors in 4,631 healthy women and men. *Med Sci Sports Exerc* 2011 (ahead of press).
5. Grimsmo J, Arnesen H, and Maehlum S. Changes in cardiorespiratory function in different groups of former and still active male cross-country skiers: a 28-30-year follow-up study. *Scand J Med Sci Sports* 2010; 20: e151-161.
6. Haskell WL, Lee IM, Pate RR, Powell KE, Blair SN, Franklin BA, Macera CA, Heath GW, Thompson PD, and Bauman A. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Med Sci Sports Exerc* 2007; 39: 1423-1434.
7. Hawkins SA, Wiswell RA, and Marcell TJ. Exercise and the master athlete--a model of successful aging? *J Gerontol A Biol Sci Med Sci* 2003; 58: 1009-1011.
8. Kibler WB, and Putukian M. Selected issues for the master athlete and the team physician: a consensus statement. *Med Sci Sports Exerc* 2010; 42: 820-833.
9. Kokkinos P, Myers J, Faselis C, Panagiotakos DB, Doumas M, Pittaras A, Manolis A, Kokkinos JP, Karasik P, Greenberg M, Papademetriou V, and Fletcher R. Exercise capacity and mortality in older men: a 20-year follow-up study. *Circulation* 2010; 122: 790-797.
10. Lee DC, Artero EG, Sui X, and Blair SN. Mortality trends in the general population: the importance of cardiorespiratory fitness. *J Psychopharmacol* 2010; 24: 27-35.
11. Lloyd-Jones DM, Hong Y, Labarthe D, Mozaffarian D, Appel LJ, Van Horn L, Greenlund K, Daniels S, Nichol G, Tomaselli GF, Arnett DK, Fonarow GC, Ho PM, Lauer MS, Masoudi FA, Robertson RM, Roger V, Schwamm LH, Sorlie P, Yancy CW, and Rosamond WD. Defining and setting national goals for cardiovascular health promotion and disease reduction: the American Heart Association's strategic Impact Goal through 2020 and beyond. *Circulation* 2010; 121: 586-613.
12. McGavock JM, Hastings JL, Snell PG, McGuire DK, Pacini EL, Levine BD, and Mitchell JH. A forty-year follow-up of the Dallas Bed Rest and Training study: the effect of age on the cardiovascular response to exercise in men. *J Gerontol A Biol Sci Med Sci* 2009; 64: 293-299.
13. McGuire DK, Levine BD, Williamson JW, Snell PG, Blomqvist CG, Saltin B, and Mitchell JH. A 30-year follow-up of the Dallas Bedrest and Training Study: II. Effect of age on cardiovascular adaptation to exercise training. *Circulation* 2001; 104: 1358-1366.
14. O'Donovan G, Blazevich AJ, Boreham C, Cooper AR, Crank H, Ekelund U, Fox KR, Gately P, Giles-Corti B, Gill JM, Hamer M, McDermott I, Murphy M, Mutrie N, Reilly JJ, Saxton JM, and Stamatakis E. The ABC of Physical Activity for Health: a consensus statement from the British Association of Sport and Exercise Sciences. *J Sports Sci* 2010; 28: 573-591.
15. Powell KE, Paluch AE, and Blair SN. Physical activity for health: what kind? how much? how intense? on top of what? *Annu Rev Public Health* 2011; 32: 1-17.
16. Talbot LA, Metter EJ, and Fleg JL. Leisure-time physical activities and their relationship to cardiorespiratory fitness in healthy men and women 18-95 years old. *Med Sci Sports Exerc* 2000; 32: 417-425.
17. Vianna LC, Oliveira RB, and Araujo CGS. Age-related decline in handgrip strength differs according to gender. *J Strength Cond Res* 2007; 21: 1310-1314.