International Journal of Aquatic Research and Education

Volume 3 | Number 1 Article 2

2009

Research Needs in Aquatics

Bruce E. Becker
Washington State University

International Journal of Aquatic Research and Education, 2009, 3, 4-9

Research Needs in Aquatics

Since my retirement from my clinical practice in 2007, and repotting myself as a research professor at Washington State University where I direct the National Aquatic & Sports Medicine Institute, I have dedicated myself to researching those questions in aquatic activity that I feel we have the capacity and skills to answer. While that has been truly invigorating to this academic wannabe, it has left me with a strong sense of frustration over the many questions that we are not currently researching or that we lack the skills, population, or technology to answer. In discussing these frustrations with Steve Langendorfer, your journal editor, the thought came to both of us that an editorial talking about these research questions might be a useful endeavor, sort of like a Craig's List posting, hoping to find a buyer for these questions. I have organized them not by listing of importance, but rather by categorizing them into body parts, like any medical specialist would do. (After all, I was not a general practitioner; I was a left third toe specialist, sometimes getting into right elbow issues as well.)

What Are the Primary Research Needs in Aquatic Activity?

Organ Specific

Cardiac Issues. There are a great many research needs that involve the heart. Recent research has shown quite conclusively that the aquatic environment is helpful to both health and diseased hearts (Cider, Sunnerhagen, Schaufelberger, & Andersson, 2005; Cider, Svealv, Tang, Schaufelberger, & Andersson, 2006; Meyer, 2006; Meyer & Bucking, 2004; Meyer & Leblanc, 2008; Schmid et al., 2007); however, the research is interesting, showing that even in those individuals whose indices of cardiac performance were impaired after aquatic activity, they felt better. Why might this be? There is no dose-response data on what timing, levels, and duration of aquatic activity are appropriate for the healing heart, and this is a critical area, as the potential benefits of timing cardiac rehab activity correctly could create a faster recovery and lower morbidity and mortality. The science has been done on heart failure and infarct patients, but there is no data on postsurgical patients, another important research area. Further, there may well be concerns regarding valvular insufficiency, which might worsen during immersion, because of the anatomic changes occurring with increasing cardiac volumes. To my knowledge there is no data on this, and perhaps there might be actual contraindications regarding aquatic activity in this population.

Respiratory Issues. The respiratory system has been the subject of much research lately, and there is a great deal of well-done older research on the respiratory system during immersion. This research shows that there is a very substantial increase in the work of breathing during immersion at rest (Agostoni, Gurtner, Torri, & Rahn, 1966; Arborelius, Balldin, Lilja, & Lundgren, 1972; Craig & Ware, 1967; Hong, Cerretelli, Cruz, & Rahn, 1969; Reid, Banzett, Feldman, & Mead, 1985; Taylor & Morrison, 1999). There is almost no research measuring the increased workload during aquatic exercise, and this is important because respiratory fatigue is a critical performance-limiting factor in athletics, but also for some chronic diseases like COPD, muscular dystrophy, and asthma. It is well established that by building endurance in the muscles of respiration, athletic performance is improved (Romer, McConnell, & Jones, 2002a, 2002b; Sheel et al., 2001; Volianitis et al., 2001). This happens by inhibiting a metabolic reflex that shuts down circulation to the lower extremities; however, this kind of respiratory endurance building also improves disease symptoms and quality of life in these chronic diseases (Belman, 1981; Belman & Gaesser, 1988; Belman & Mittman, 1980; Fry, Pfalzer, Chokshi, Wagner, & Jackson, 2007; Perk, Perk, & Boden, 1996; Topin et al., 2002). Can aquatic exercise do this? I believe so, and we have done some research into this area but much more is needed. In my opinion, this may well be the most important physiologic benefit of aquatic exercise.

Musculoskeletal Issues. The physiologic benefits of offloading the joints during immersion are well known and adequately researched, but exactly what the effects of this offloading are within the joint remain enigmatic. Does this improve circulation? Does this increase synovial fluid production? Can this rebuild damaged cartilage? Are there useful temperatures and harmful ones? Cold water is used in some countries for this, but in the USA, we mostly use warm water. Why? Also, chiller tanks and cold water immersion is frequently used by sports teams as a postexercise recovery method. The literature is conflicted on this use, but the practice is increasing in frequency (Bailey et al., 2007; Crowe, O'Connor, & Rudd, 2007; Ducharme, VanHelder, & Radomski, 1991; Folland, Rowlands, Thorp, & Walmsley, 2006; Kauppinen, 1989; Nobunaga, Ishii, & Yoshida, 1996; O'Brien, Tharion, Sils, & Castellani, 2007; Peiffer, Abbiss, Nosaka, Peake, & Laursen, 2007; Vaile, Halson, Gill, & Dawson, 2008). Better research is needed.

Disease Specific

Diabetes. Diabetes has assumed a huge place in the health care budget of the USA. Both juvenile and adult Type 2 diabetes is greatly on the rise. Immersion may play a role in reducing insulin needs, and of course exercise is very helpful in the management of diabetes, but there is scant research on either the effects of aquatic activity and immersion on insulin needs or health protection in the management of diabetes. Research showing the effect of aquatic activity in turning back prediabetes and preventing development into full-blown diabetes would make national headlines. This may or may not be the case, but there is preliminary evidence that makes the speculation reasonable as a research hypothesis. Furthermore, can aquatic activity done regularly improve diabetic neuropathy? I have had patients tell me this, but no studies have shown so thus far.

Asthma. Asthma is another serious chronic problem in America. Aquatic activity has been stated to be the ideal exercise mode for asthmatics, but also to exacerbate

https://scholarworks.bgsu.edu/ijare/vol3/iss1/2
DOI: 10.25035/ijare.03.01.02

asthma if air quality is poor in the pool area. What is the ideal aquatic environment for an asthmatic person and what exercises are most ideal?

Arthritis. Again, what temperatures are optimal for persons with arthritis, and are there significant differences between needs for osteoarthritis (the non-inflammatory kind) and for rheumatoid arthritis? These questions could be studied by virtually any therapist with a sufficiently large population of patients and some design support from a local health care facility with research interest.

Parkinsonism. Parkinsonism is a quite common problem, and there is evidence that aquatic programs are useful in its management, but there is little or no research on what programs are most useful, what therapeutic techniques work best, and what water temperatures and depths most effective and efficient. There is no dose-response data on treatment frequency and duration either. These are not studies that require high-level technology, and could be done by practically anyone working as a therapist with a Parkinsonism support group.

Osteoporosis. A very common problem seen by nearly all aquatic therapists is osteoporosis, but the role of aquatics in managing osteoporotic patients remains controversial. Certainly it is possible to build strength and balance in persons following an osteoporotic fracture, but can one build bone? The evidence is mixed, with a few studies having shown some effect, others none (Chu & Rhodes, 2001; Drinkwater, 1994; Hoshi, Watanabe, Chiba, & Inaba, 1998; Pedersen & Saltin, 2006; Swissa-Sivan et al., 1992; Why do you recommend swimming, 2001). It would be useful to have the answers to this important health care problem. I suspect that for post-menopausal females, the answer is that aquatic exercise is not a sufficient bone-loading challenge to add bone mineral, but my opinion is based on peripheral research rather than directly applicable studies. I would love to know the truth.

Function Specific

Balance. Aquatic activity has been shown to improve balance in persons with balance limitations (Kaneda, Sato, Wakabayashi, Hanai, & Nomura, 2008; Seynnes, Hue, Ledrole, & Bernard, 2002; Suomi & Koceja, 2000). The ideal exercise routines remain to be studied, and to date there is no data on dose-response questions. Both deep-water and routine aquatic exercises have been studied, but there are no balance-specific training protocols that have been tested. Insurance carriers would likely reimburse a program that was scientifically proven to be effective and efficient, but none have appeared to date.

Strength, Endurance, Coordination. All three of these functional issues are important research areas. To date, we have typically applied the standard protocols of the American College of Sports Medicine, but there may be differences in biologic response to aquatic activity, because muscle circulation is different in water, just as circulation is enhanced. Perhaps the standard training protocols are not applicable, and we could safely use higher doses of exercise or greater frequencies. After all, many competitive swimmers training water far longer than track athletes do with safety.

Quality of Life

Mood and Emotion. Exercise in general has a very potent effect on mood state and emotion, and it would appear from cruising through the therapy pool that aquatic exercise is even more potent in this respect. That said, the data are not there to say that aquatics is equal or superior to land exercise, unfortunately. I believe that a well-designed study would prove that it is, but these studies remain to be done. I also believe that because some evidence shows that brain circulation may increase during immersion, aquatic exercise just might improve cognition. If this were true, just how important do you think aquatic activity might be in the management of Alzheimer's or other cognitive problems?

Cognition and Cognitive Functioning. As I've stated above, some research has shown that brain circulation may be increased during immersion. Research in our lab has shown immersion to produce autonomic nervous system effects that are associated with increased working memory, executive cognitive skills, and cognitive flexibility. Does aquatic exercise produce improvement in thinking skills? If you are reading this journal, I am sure you believe this to be true. But the research has yet to prove it.

So as you can see, there is a lot of work to be done. Certainly this represents many years of work. But I believe that aquatic activity has unique health-promoting benefits, and recent studies published in this journal support that belief (Chase, Sui, & Blair, 2008a, 2008b). If my belief was supported by competent research, just think how much healthier our world might be, with public aquatic facilities available across the country, swimming training incorporated into elementary education as a critical life skill, pools crowded with happy healthy people of every age and ability or disability, and this journal expanded into hundreds of pages. It is time to get to work.

References

Agostoni, E., Gurtner, G., Torri, G., & Rahn, H. (1966). Respiratory mechanics during submersion and negative-pressure breathing. Journal of Applied Physiology, 21(1), 251-258.

Arborelius, M. Jr., Balldin, U.I., Lilja, B., & Lundgren, C.E. (1972). Hemodynamic changes in man during immersion with the head above water. Aerospace Medicine, 43(6), 592-598.

Bailey, D.M., Erith, S.J., Griffin, P.J., Dowson, A., Brewer, D.S., Gant, N., et al. (2007). Influence of cold-water immersion on indices of muscle damage following prolonged intermittent shuttle running. Journal of Sports Science, 25(11), 1163-1170.

Belman, M.J. (1981). Respiratory failure treated by ventilatory muscle training (VMT). A report of two cases. European Journal of Respiratory Diseases, 62(6), 391-395.

Belman, M.J., & Gaesser, G.A. (1988). Ventilatory muscle training in the elderly. Journal of Applied Physiology, 64(3), 899-905.

Belman, M.J., & Mittman, C. (1980). Ventilatory muscle training improves exercise capacity in chronic obstructive pulmonary disease patients. American Review of Respiratory Diseases, 121(2), 273-280.

https://scholarworks.bgsu.edu/ijare/vol3/iss1/2
DOI: 10.25035/ijare.03.01.02

Chase, N.L., Sui, X., & Blair, S.N. (2008a). Comparison of the health aspects of swimming with other types of physical activity and sedentary lifestyle habits. International Journal of Aquatic Research & Education, 2(2), 151-161.

Chase, N.L., Sui, X., & Blair, S.N. (2008b). Swimming and all-cause mortality risk compared with running, walking, and sedentary habits in men. International Journal of Aquatic Research and Education, 2(3), 213-223.

Chu, K.S., & Rhodes, E.C. (2001). Physiological and cardiovascular changes associated with deep water running in the young. Possible implications for the elderly. Sports Medicine, 31(1), 33-46.

Cider, A., Sunnerhagen, K.S., Schaufelberger, M., & Andersson, B. (2005). Cardiorespiratory effects of warm water immersion in elderly patients with chronic heart failure. Clinical Physiology Function Imaging, 25(6), 313-317.

Cider, A., Svealv, B.G., Tang, M.S., Schaufelberger, M., & Andersson, B. (2006). Immersion in warm water induces improvement in cardiac function in patients with chronic heart failure. European Journal of Heart Failure, 8(3), 308-313.

Craig, A.B. Jr., & Ware, D.E. (1967). Effect of immersion in water on vital capacity and residual volume of the lungs. Journal of Applied Physiology, 23(4), 423-425.

Crowe, M.J., O'Connor, D., & Rudd, D. (2007). Cold water recovery reduces anaerobic performance. International Journal of Sports Medicine, 28(12), 994-998.

Drinkwater, B.L. (1994). 1994 C.H. McCloy research lecture: Does physical activity play a role in preventing osteoporosis? Research Quarterly of Exercice and Sport, 65(3), 197-206.

Ducharme, M.B., VanHelder, W.P., & Radomski, M.W. (1991). Cyclic intramuscular temperature fluctuations in the human forearm during cold-water immersion. European Journal of Applied Physiology, 63(3-4), 188-193.

Folland, J.P., Rowlands, D.S., Thorp, R., & Walmsley, A. (2006). Leg heating and cooling influences running stride parameters but not running economy. International Journal of Sports Medicine, 27(10), 771-779.

Fry, D.K., Pfalzer, L.A., Chokshi, A.R., Wagner, M.T., & Jackson, E.S. (2007). Randomized control trial of effects of a 10-week inspiratory muscle training program on measures of pulmonary function in persons with multiple sclerosis. Journal of Neurological Physical Therapy, 31(4), 162-172.

Hong, S.K., Cerretelli, P., Cruz, J.C., & Rahn, H. (1969). Mechanics of respiration during submersion in water. Journal of Applied Physiology, 27(4), 535-538.

Hoshi, A., Watanabe, H., Chiba, M., & Inaba, Y. (1998). Bone density and mechanical properties in femoral bone of swim loaded aged mice. Biomedical Environmental Science, 11(3), 243-250.

Kaneda, K., Sato, D., Wakabayashi, H., Hanai, A., & Nomura, T. (2008). A comparison of the effects of different water exercise programs on balance ability in elderly people. [Research]. Journal of Aging and Physical Activity, 16(4), 381-392.

Kauppinen, K. (1989). Sauna, shower, and ice water immersion. Physiological responses to brief exposures to heat, cool, and cold. Part II. Circulation. Arctic Medical Research, 48(2), 64-74.

Meyer, K. (2006). Left ventricular dysfunction and chronic heart failure: should aqua therapy and swimming be allowed? British Journal of Sports Medicine, 40(10), 817-818.

Meyer, K., & Bucking, J. (2004). Exercise in heart failure: Should aqua therapy and swimming be allowed? Medicine and Science in Sports and Exercise, 36(12), 2017-2023.

Meyer, K., & Leblanc, M.C. (2008). Aquatic therapies in patients with compromised left ventricular function and heart failure. Clinical Investment Medicine, 31(2), E90-97.

Nobunaga, M., Ishii H., & Yoshida F. (1996). Balneotherapy for patients with rheumatoid arthritis, especially the effect of cold spring water bathing. In O.Y. Agishi (Ed.), New frontiers in health resort medicine (pp. 109). Noboribetsu, Japan: Hokkaido University School of Medicine Press.

O'Brien, C., Tharion, W.J., Sils, I.V., & Castellani, J.W. (2007). Cognitive, psychomotor, and physical performance in cold air after cooling by exercise in cold water. Aviation Space Environmental Medicine, 78(6), 568-573.

Pedersen, B.K., & Saltin, B. (2006). Evidence for prescribing exercise as therapy in chronic disease. Scandinavian Journal of Medicine and Science in Sports, 16 Suppl 1, 3-63.

Peiffer, J.J., Abbiss, C.R., Nosaka, K., Peake, J.M., & Laursen, P.B. (2007). Effect of cold water immersion after exercise in the heat on muscle function, body temperatures, and vessel diameter. Journal of Science and Medicine in Sport.

Perk, J., Perk, L., & Boden, C. (1996). Cardiorespiratory adaptation of COPD patients to physical training on land and in water. European Respiratory Journal, 9(2), 248-252.

Reid, M.B., Banzett, R.B., Feldman, H.A., & Mead, J. (1985). Reflex compensation of spontaneous breathing when immersion changes diaphragm length. Journal of Applied Physiology, 58(4), 1136-1142.

Romer, L.M., McConnell, A.K., & Jones, D.A. (2002a). Effects of inspiratory muscle training upon recovery time during high intensity, repetitive sprint activity. International Journal of Sports Medicine, 23(5), 353-360.

Romer, L.M., McConnell, A.K., & Jones, D.A. (2002b). Inspiratory muscle fatigue in trained cyclists: Effects of inspiratory muscle training. Medicine and Science in Sports & Exercise, 34(5), 785-792.

Schmid, J.P., Noveanu, M., Morger, C., Gaillet, R., Capoferri, M., Anderegg, M., et al. (2007). Influence of water immersion, water gymnastics and swimming on cardiac output in patients with heart failure. Heart, 93(6), 722-727.

Seynnes, O., Hue, O., Ledrole, D., & Bernard, P.L. (2002). Adapted physical activity in old age: Effects of a low-intensity training program on isokinetic power and fatigability. Aging Clinical & Experimental Research, 14(6), 491-498.

Sheel, A.W., Derchak, P.A., Morgan, B.J., Pegelow, D.F., Jacques, A.J., & Dempsey, J.A. (2001). Fatiguing inspiratory muscle work causes reflex reduction in resting leg blood flow in humans. Journal of Physiology, 537(Pt 1), 277-289.

Suomi, R., & Koceja, D.M. (2000). Postural sway characteristics in women with lower extremity arthritis before and after an aquatic exercise intervention. Archives of Physical Medicine and Rehabilitation, 81(6), 780-785.

Swissa-Sivan, A., Statter, M., Brooks, G.A., Azevedo, J., Viguie, C., Azoury, R., et al. (1992). Effect of swimming on prednisolone-induced osteoporosis in elderly rats. Journal of Bone and Mineral Research, 7(2), 161-169.

Taylor, N.A., & Morrison, J.B. (1999). Static respiratory muscle work during immersion with positive and negative respiratory loading. Journal of Applied Physiology, 87(4), 1397-1403.

Topin, N., Matecki, S., Le Bris, S., Rivier, F., Echenne, B., Prefaut, C., et al. (2002). Dose-dependent effect of individualized respiratory muscle training in children with Duchenne muscular dystrophy. Neuromuscular Disorder, 12(6), 576-583.

Vaile, J., Halson, S., Gill, N., & Dawson, B. (2008). Effect of hydrotherapy on the signs and symptoms of delayed onset muscle soreness. European Journal of Applied Physiology, 102(4), 447-455.

Volianitis, S., McConnell, A. K., Koutedakis, Y., McNaughton, L., Backx, K., & Jones, D. A. (2001). Inspiratory muscle training improves rowing performance. Medicine & Science in Sports & Exercise, 33(5), 803-809.

Why do you recommend swimming for people with osteoporosis even though it is not weight bearing? (2001). Johns Hopkins Med Lett Health After 50, 13(10), 8.

Bruce E. Becker, Director
National Aquatic & Sports Medicine Institute
Washington State University