



Hot Water & Healthy Living

The Science of Hot-Water
Immersion: How it Promotes
Healthy Bodies, Hearts, Minds
and Lifestyles.



By
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and the
National Swimming Pool Foundation®



Hot Water & Healthy Living

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Safe Soaking

The information contained in this book, *Hot Water & Healthy Living*, represents the findings of the author. The use of hot water may carry certain risks and may not be suitable for every person. Therefore, readers are strongly urged to consult with their physician before soaking in hot water. The use of hot water may carry certain unavoidable risks, including (but not limited to) physical and medical effects of prolonged exposure to hot water, risks to pregnant women from soaking in temperatures above 102 degrees, overheating, scalding, adverse effects when combined with alcohol or other drugs, physical injury, drowning and death.⁷ Readers should follow all manufacturers' guidelines, recommendations and warnings in connection with the use of hot water and follow all applicable laws, regulations, and codes.

⁷Consumer Product Safety Commission. (n.d.). *Spas, Hot Tubs, and Whirlpools* (CPSC Document No. 5112).



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Throughout history people have been attracted to water to maintain health and recover from injury.

Preface

Startling research shows that both the body and mind benefit from the simple act of immersion in warm water. We live in a world where many people are facing serious health issues, including loss of mobility, chronic disease, depression, and premature death. Movement in water, even simple immersion in water, is an ideal way to improve our health and the quality of our lives. Regular soaking in warm water, whether it is a bath, natural hot spring, or portable spa/hot tub, shouldn't be considered an extravagance. The reality is, as you will discover in this book, soaking in warm or hot water can make a big difference in your health and daily living. The

benefits are broad, and the science is exciting. The National Swimming Pool Foundation® (NSPF®) invited Dr. Jonathan B. Smith to research existing science and to share with you how hot water helps to create healthier lives. We hope that you enjoy reading about how “getting in hot water” can lead to happier, more active lives for you, your family, and your friends. Proceeds from the book are used to fund aquatic health benefit research.

Thomas M. Lachocki, Ph.D.



The buoyancy of water acts as a buffer against the effects of gravity on an injured joint.

Introduction

Picture a recent stressful day. Perhaps you worked all day, had a disagreement, fought traffic for 30 minutes or more, and came home either tired or not prepared to shift to the demands and rewards of home life.

Now, imagine a different start to the evening. You arrive home eagerly, shed your day's worries, and slip into your personal hot tub. After lingering a few minutes in the warm water, having your muscles and joints massaged with

water jets – physical, mental, and emotional relaxation takes hold. In fact, as you climb out and dry off, you feel calm and energized for the evening ahead. Sure, life at home has its demands and stresses, but you know from experience that your evening soak can help you feel better for up to four hours. Can you see it? This is a brief picture of how regular soaking in hot water can provide a relaxing oasis in our stressful daily lives. It is like taking a little vacation every day.

Of course, no amount of scientific explanation can equal what 15 minutes soaking in hot water several times a week can mean for you. We encourage you to do more than read. Explore improving the quality of your life by trying a hot-water soak yourself. You can visit a professional hot tub retailer; many have programs to give you a private “test drive” of a hot tub.



Most people see their blood pressure go down when they are immersed in hot water.

The Potential of Warm Water Immersion

For thousands of years, civilizations have been born, developed, and prospered beside water. Throughout history, people have used water to maintain their health and to recover from injuries. We need only watch children play in puddles after a summer shower to confirm our instinctive attraction to water. Today, water activities remain very popular. The United States has over 400 million annual visits to aquatic venues such as pools,

hot tubs, fresh water outlets, and beaches.² In fact, there are over 5 million hot tubs in the United States.¹⁵

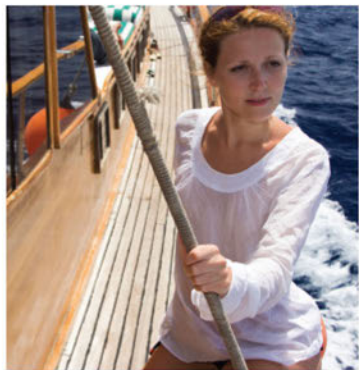
Many books, magazines, news stories, and government reports alarm us that Social Security, Medicare, secure retirement, pensions, insurance, and our average life span are all in jeopardy due to our poor health. We hear media stories every day about problems like obesity, heart

disease, diabetes, cancer, and an aging population. Yet, the general public and health-care providers are often unaware of the science that demonstrates how hot-water immersion can ease these problems.

The question many of us have is, “How can immersion in hot water benefit my health?” Our bodies make adjustments when we are immersed in water. These changes are similar to those

²Beach, M. (2006). Recreational water illness prevention and lessons learned [abstract of keynote address]. Proceedings of the *World Aquatic Health™ Conference*, Austin, TX.

¹⁵P.K. Data (2007). Media Information Summary [about number of swimming pools and spas in the United States].



Warm water immersion provides a safe, relaxing way to unwind, reduce anxiety, and cope more effectively with the challenges of daily life.

that occur when we exercise. The changes include increased circulation, more efficient breathing, and improvements in mood.³ It is well known that when a person's body is immersed in water, the water's pressure affects almost every part of the body. When immersed, the body must adjust to the pressure from the surrounding warm water. The result is greater cardiac output and lower resting pulse rate. Also, the water pressure and hot temperature help the body to release chemicals (hormones)

that help us relax and improve our mood.

This book summarizes the present knowledge about many health benefits that result from immersion in hot water. Specifically, the book highlights how hot-water immersion can help to heal our injuries, exercise our heart, and improve our mental health.

Water has unique healing properties and physiologic effects.

³Becker, B. and Cole, A. (2004). *Comprehensive Aquatic Therapy*, 2nd ed. Philadelphia: Butterworth Heineman.



Hot Water & Healing

As we experience life, we often feel pain and sore muscles and joints. Healing happens faster as blood flow to the injured location increases. When we perform light exercise, our muscles are often less sore.^{16,20} This is because exercise increases blood flow, thus improving the healing. Immersion in all temperatures of water has been used extensively for years to promote the healing of wounds and injuries. The

success and positive results associated with water immersion have been noted in the healing of wounds.⁴ More specifically, water immersion helps in the healing of muscles and/or joint injuries.

There are several ways in which hot-water immersion improves healing:

⁴Becker, B. (2007). Personal communication to author based on 30 years of clinical experience.

¹⁶Quill, Scott. (2007, Jan-Feb). Reduce soreness by 40 percent. *Men's Health*, 22, 46.

²⁰Rahnama, N., Rahmani-Nia, F., & Ebrahim, K. (2005). The isolated and combined effects of selected physical activity and ibuprofen on delayed-onset muscle soreness. *Journal of Sports Sciences*, 23, 843-850.

1 Immersion increases circulation. When muscles are warmed and the body is immersed, the blood supply to the area muscles increases. More blood flow means more nutrients are available to help cells regenerate in order to speed the healing process. Also, the increase in blood circulation helps remove pain-causing chemicals that build up in tissues. As a result, muscle pain goes away faster.

2 When our bodies are immersed, water exerts pressure on our body. This increased pressure tends to reduce swelling. For example, our ankles and feet are less likely to swell in water than on land.

3 The buoyancy of the water provides unique benefits that are significant. Immersion in water reduces the amount of weight we bear on our joints due to gravity. The result is that we

feel lighter in water. Activities we may find painful on land are easier in water. Water is thicker than air and provides resistance to movements. The resistance increases depending on how fast we move against the water. This is called graded resistance, which is helpful when we exercise in water to help recover from injuries. Numerous studies demonstrate the increased range of motion and decreased pain when therapeutic exercise is performed under water.^{11,13,24}

¹¹Hinman, R. S., Heywood, S. E., & Day, A. R. (2007). Aquatic physical therapy for hip and knee osteoarthritis: Results of a single-blind randomized controlled trial. *Physical Therapy*, 87, 32-43.

¹³Keegan, L., & Keegan, G. (1998). *Healing Waters: The miraculous health benefits of earth's most essential resource*. New York: Berkeley/Putnam.

²⁴Suomi, R., & Lindauer, S. (1997). Effectiveness of arthritis foundation aquatic program on strength and range of motion in women with arthritis. *Journal of Aging and Physical Activity*, 5, 341-351.

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Being able to “get around” is very important to most people. Water plays a useful role for people who suffer from arthritis, knee, hip, or other joint problems. Immersion in warm water tends to increase joint mobility, reduce joint stiffness, and increase flexibility and range of motion. For example, people with arthritis and lower back pain experience

greater flexibility and less pain with regular use of warm water immersion.^{5,10,28}

Therapy can be painful. Performing therapy in water is often less painful. Professionals who provide therapy recognize that immersion can lead to a faster and a longer-lasting recovery.^{3,12} As a result, water

is commonly used in physical therapy and rehabilitation. An environment which is less prone to cause pain, and is even pleasurable, makes immersion in warm water a unique healing environment.³

⁵Becker, B. and Cole, A. (2004). *Comprehensive Aquatic Therapy*, 2nd ed. Philadelphia: Butterworth Heineman.

⁶Bellometti, S., Gallotti, C., Pacileo, G., Rota, A., & Tenconi, M.T. (2007). Evaluation of outcomes in SPA-treated osteoarthrosic patients. *Journal of Preventive Medicine and Hygiene*, 48, 1-4.

¹⁰Hashkes, P. J. (2002). Beneficial effect of climatic therapy on inflammatory arthritis at Tiberias Hot Springs. *Scandinavian Journal of Rheumatology*, 31, 172-177.

¹¹Hinman, R. S., Heywood, S. E., & Day, A. R. (2007). Aquatic physical therapy for hip and knee osteoarthritis: Results of a single-blind randomized controlled trial. *Physical Therapy*, 87, 32-43.

¹²Keegan, L. (2003). Alternative and complementary modalities for managing stress and anxiety. *Critical Care Nurse*, 23, 55-58.

¹³Keegan, L., & Keegan, G. (1998). *Healing Waters: The miraculous health benefits of earth's most essential resource*. New York: Berkeley/Putnam.

²⁸Suomi, R., & Lindauer, S. (1997). Effectiveness of arthritis foundation aquatic program on strength and range of motion in women with arthritis. *Journal of Aging and Physical Activity*, 5, 341-351.

²⁹Yurtkuran, M., Kahraman, Z., Sivrioglu, K., Afsin, Y., & Dogan, M. (1997). Balneotherapy in low back pain. *European Journal of Physical Medicine and Rehabilitation*, 7, 120-123.



Healing happens faster as blood flow to the injured location increases.



Hot Water & Heart Health

Our hearts pump blood through the circulatory system (arteries and veins) to all parts of the body. The veins and arteries expand and contract depending on the volume of blood being pumped. Blood circulates oxygen and nutrients throughout the body and carries waste away from cells. When we exert ourselves or when we exercise, our hearts pump faster and stretch to pump more blood per stroke in order to transport needed oxygen and nutrients throughout the body.

When we exercise, our hearts adjust in two ways to make sure we get enough oxygen and nutrients to wherever they are needed. First, the heart beats faster; this is called our heart rate or pulse rate. Second, the heart stretches to pump more blood with every stroke; the amount of blood that the heart pumps in each beat, or stroke, is called our “stroke volume.”

Since we have a maximum pulse rate dictated by our age, we cannot increase it. Your maximum heart rate is about 220 minus your age.

Age (years)	Target Heart Rate Zone 50-85% (beats per minute)	Average Maximum Heart Rate: 100% (beats per minute)
20	100-170	200
25	98-166	195
30	95-162	190
35	93-157	185
40	90-153	180
45	88-149	175
50	85-145	170
55	83-140	165
60	80-136	160
65	78-132	155
70	75-128	150



However, when we exercise regularly, we can improve or increase our stroke volume. Thus, stroke volume is a key measure about our heart's health.

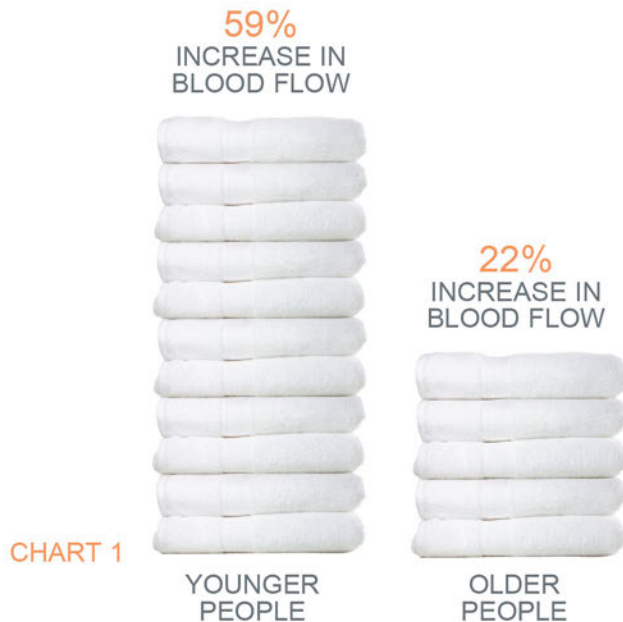
When we get in the water, our heart stretches as it does during exercise, even if we are just soaking in the water. Here is how that happens: During immersion, the water exerts pressure on all parts of the body, including the arteries and veins that carry blood throughout the body. The water's pressure on our legs and arms pushes blood toward the chest cavity, increasing blood flow

to the heart by about one third (33 percent). Since more blood is being pushed to our heart, it adjusts by stretching.

When we are in the water, our heart pumps more blood per beat. So, our pulse rate may increase or decrease depending on the temperature of the water and if we are exerting ourselves or not. Although the arteries and veins, which circulate blood, are being compressed from the water pressure, they also must adjust to the higher output from the heart. The arteries expand (dilate), working against the water pressure

to allow higher blood volume to move throughout the body. Therefore, when a person is immersed in warm water, the heart is working harder and more efficiently, like it does when we exercise. The arteries and veins dilate to carry more blood. Blood moves more easily through the body and circulation may be improved.

Chart 1 shows that people of all ages benefit from increased blood flow when immersed in shoulder-depth water, although the effect diminishes as we age.²⁵



²⁵Tajima, et al. (1988). Renal and endocrine responses in the elderly during head-out water immersion. *American Journal of Physiology*, 254 (6 Pt 2), R977-R983.

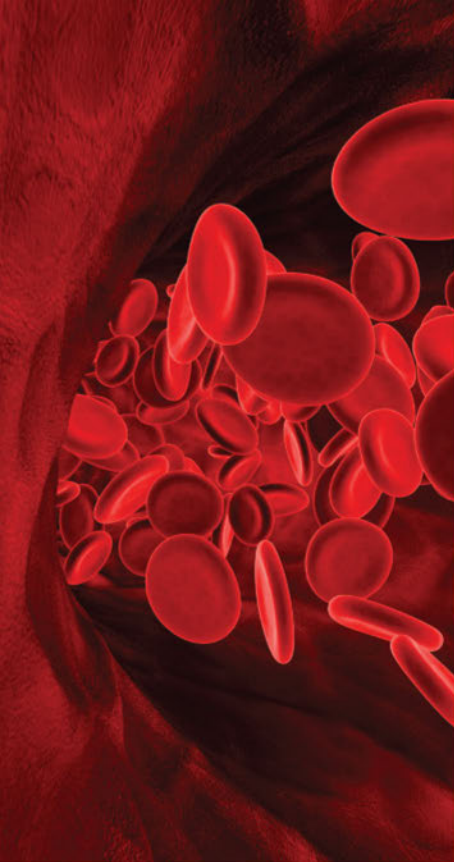


Chart 2 shows that blood flow increases in people as water temperature increases for people who are immersed up to their shoulders.²⁷ Of course, immersion in water above 104°F is not recommended. Research sponsored by the National Swimming Pool Foundation® (NSPF®) is under way to verify how blood flow changes at the shallow depths and higher temperatures present in hot tubs.

Most people see their blood pressure go down when they are immersed in warm water for a period of time.^{3,1} A recent study found that people being treated for high blood pressure used a hot tub with no ill effects. In fact, their blood pressure went down temporarily and their heart rate increased, just as it did with the non-hypertensive control group.²²

¹Allison, T. G., Miller, T. D., Squires, R. W., & Gau, G. T. (1993). Cardiovascular responses to immersion in a hot tub in comparison with exercise in male subjects with coronary artery disease. *Mayo Clinic Proceedings*, 63, 19-25.

³Becker, B. and Cole, A. (2004). *Comprehensive Aquatic Therapy*, 2nd ed. Philadelphia: Butterworth Heineman.

²²Shin, T. W., Wilson, M., & Wilson, T. W. (2003). Are hot tubs safe for people with treated hypertension? *Canadian Medical Association Journal*, 169, 1265-1268.

²⁷Weston, C.F., et al. (1987). Hemodynamic changes in man during immersion in water at different temperatures. *Clinical Sci*. 73, 613-616.

People with high blood pressure may wish to consult with their physician to determine whether hot tub immersion may help them.





Hot Water & Relaxation

It is widely accepted that soaking in hot water is relaxing. Each of us normally feels refreshed when we emerge from a shower or bath. The effects of warm water are enhanced by water pressure when we are immersed in deeper water. The available scientific research explains the impact hot-water immersion has on the body.

The body's nervous system is designed to respond to physical or emotional threats or "stresses" as part of our survival instinct. The nervous system helps us

relax after the threat has passed. Long-term stress is unhealthy and has been linked to many causes of disease and death. When we are threatened or "stressed," our body creates hormones that trigger an increased blood flow:

- Our hearts beat faster
- Our heart stroke volume increases
- We breathe faster to oxygenate the higher blood volume
- Other coping responses occur

This increase in blood flow prepares our body for a fight so that we can protect ourselves from the threat. Similarly, the body has to be prepared to flee if needed. These natural responses prepare us for “fight or flight.”

The part of our nervous system that prepares us to deal with stress is called the sympathetic branch. The sympathetic branch is important in the human’s survival instincts. However, if we are stressed too much and too often, our long-term health

suffers.²⁶ Fortunately, the body has a system (the parasympathetic branch) to create hormones that cause the body to relax after the stress has passed.

Physicians agree that managing stress will increase our chances for healthier and happier lives.¹² Scientific evidence shows that immersion in water helps us reduce the effects of stress.²¹

Immersion in hot water helps our body relax by allowing the parasympathetic branch to reverse the effects of the sympathetic branch. Dopamine, a hormone that causes relaxation, is released when a person is immersed in hot water; the formation of this hormone shows an increased parasympathetic response.^{3,8}

Immersion in hot water helps the body relax.

³Becker, B. and Cole, A. (2004). *Comprehensive Aquatic Therapy*, 2nd ed. Philadelphia: Butterworth Heineman.

⁶Grossman, E. et al. Effects of water immersion on sympathoadrenal and dopa-dopamine systems in humans. *American Journal of Physiology*, 262 (6 pt 2), R993-R999.

¹²Keegan, L. (2003). Alternative and complementary modalities for managing stress and anxiety. *Critical Care Nurse*, 23, 55-58.

²¹Robiner, W.N. (1990). Psychological and physical reactions to whirlpool baths. *Journal of Behavioral Medicine*, 13, 157-173.

²⁶Torpy, J. M. Acute emotional stress and the heart. *Journal of the American Medical Association*, 298, 260.



Hot Water & Mental Health

Everyday life can provide many stresses. These include anxiety, stress, pain, fatigue, addiction, poor energy levels, range of motion problems, and lack of sleep, just to name a few. Anxiety is a particular concern, since research shows that 17% of Americans develop anxiety disorders each year.¹⁹ Anxiety impacts each of us and can be caused by major changes such as

death of a loved one, marriage, divorce, a new job, or changing your residence.

There are many ways to treat and reduce anxiety like therapy, medication, and exercise. Unfortunately, we may choose non-healthy ways to cope with anxiety like over-eating, smoking, alcohol, or drugs. These unhealthy ways to cope can place added stress on our own bodies and

¹⁹Keegan, L., & Keegan, G. (1998). *Healing Waters: The miraculous health benefits of earth's most essential resource*. New York: Berkeley/Putnam.

¹⁸Michalsen, A., Ludtke, R., Buhning, M., Spahn, G., Langhorst, J., Dobos, G. J. (2003). Thermal hydrotherapy improves quality of life and hemodynamic function in patients with chronic heart failure. *American Heart Journal*, 146, E11.

¹⁷Raglin, J. S., Wilson, G. S., & Galper, D. (2007). Exercise and its effects on mental health. In Bouchard, C., Blair, S. N., & Haskell, W. L. (Eds.). *Physical Activity and Health*. Champaign, IL: Human Kinetics, 247-257.

on those around us. Scientific evidence suggests that hot-water immersion can reduce the effects of stress naturally and contribute to improved mental health.^{13,14} Exercise and warm water immersion provide healthy ways to cope with the challenges of daily life.

Body and muscle temperatures increase during warm water immersion. As a result, it is common to experience relaxation, relief from worrisome aches and

pains, and a decrease in fatigue. Even a five-minute hot shower can lead to reductions of anxiety.¹⁸ In fact, one study demonstrated that taking a bath in the evening helps people fall asleep more easily.²³ The relaxing effects of warm water have also been found to ease the pain and stress of labor and childbirth.^{6,29}

Taking a relaxing break in hot water may also separate us from sources of stress, which can lead to a decrease in anxiety.¹⁹ Many

people report an energizing effect that typically lasts about four hours.¹⁷ After three to four weeks of daily warm water immersion for recommended periods of time, additional benefits may result. These include increased joint flexibility, reduced stress and anxiety, better sleep, and a general sense of well-being.^{9,11,23}

The social impact of soaking in a hot tub may also contribute to reduced anxiety and a sense of well-being.

⁶Benfield, R. D. (2002). Hydrotherapy in labor. *Journal of Nursing Scholarship*, 34, 347-352.

⁹Guillemin, F., Constant, F., Collin, J. F., & Boulange, M. (1994). Short- and long-term effect of spa therapy in chronic low back pain. *British Journal of Rheumatology*, 33, 148-151.

¹¹Hinman, R. S., Heywood, S. E., & Day, A. R. (2007). Aquatic physical therapy for hip and knee osteoarthritis: Results of a single-blind randomized controlled trial. *Physical Therapy*, 87, 32-43.

¹⁷Raglin, J. S. Anxiolytic effects of exercise. (1997). *Physical Activity and Mental Health*. W.P. Morgan (Ed.). Washington, DC: Taylor & Francis, 107-126.

¹⁸Raglin, J. S. & Morgan, W. P. (1987). Influence of acute exercise and quiet rest on state anxiety and blood pressure. *Medicine and Science in Sports and Exercise*, 19, 457-463.

¹⁹Raglin, J. S., Wilson, G. S., & Galper, D. (2007). Exercise and its effects on mental health. In Bouchard, C., Blair, S. N., & Haskell, W. L. (Eds.). *Physical Activity and Health*. Champaign, IL: Human Kinetics, 247-257.

²³Sung, E. J., & Tochihiro, Y. (2000). Effects of bathing and hot footbath on sleep in winter. *Journal of Physiological Anthropological Applied Human Science*, 19, 21-27.

²⁹Zanetti-Dallenbach, R., Lapaire, O., Maertens, A., Holzgreve, W., & Hosli, I. (2006). Water birth, more than a trendy alternative: A prospective, observational study. *Archives of Gynecology & Obstetrics*, 274, 355-365.



Scientific findings show hot-water immersion benefits your heart, lungs, and mind.

Hot Water & Life

Hot-water immersion is ideal to improve the quality of life and health for many people. This book summarizes some of the scientific findings showing how hot-water immersion impacts and benefits your joints, muscles, heart, lungs, and mind. Hot-water immersion may not be the best option for every individual, since each person's medical condition, living environment, and other factors may differ. It is important to consult with your physician to best judge how hot-water soaking can help you.

Now, imagine the many ways soaking in a hot tub can add quality to your daily life:

- A bridge between workday and evening activities
- A luxurious retreat to reduce stress and anxiety
- A haven for attitude adjustment
- A place to reconnect with family and friends in the comfort of your own backyard
- A healthy alternative to unhealthy habits
- An aid in rehabilitation, healing, and physical relaxation

Whether you enjoy a warm soak in your bath tub or relax in a personal hot tub, we hope you will take the time to experience the long-term benefits of soaking in warm and hot water.

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About the Author

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About NSPF®

The National Swimming Pool Foundation® (NSPF) is a non-profit organization founded in 1965, committed to encouraging healthier living and improving public health worldwide by creating a safer aquatic environment through education and research and attracting more people to aquatic exercise. The foundation works toward its mission with educational products like the Certified Pool-Spa Operator® (CPO®) certification training, Certified Pool-Spa Inspector™ (CPI™) training, the NSPF® Pool-Spa Operator™ Handbook, the Pool Math™ Workbook (both also available in Spanish), the Aquatic Play Feature Handbook™, Pool Operator Primer™, Pool Operator Fusion™, the Aquatic Safety Compendium™, eProAcademy™ online training center, the World Aquatic Health™ Conference, and the International Journal of Aquatic Research and Education (IJARE), a respected source for research and educational information published in partnership with Human Kinetics. NSPF reinvests its educational revenue and is the leader in funding grants to prevent illness, injury, drowning, and suction entrapment. The foundation is also the largest funding source for grants to study aquatic health benefits.





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