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Incorporating traditional Finnish Winter Swimming into Physiotherapy for treating Chronic Pain.

A Systematized Literature Review

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Incorporating Traditional Finnish Winter Swimming into Physiotherapy for treating Chronic Pain – A Systematized Literature Review

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The present thesis is inspired by the Environmental Physiotherapy Association and shows how physiotherapy can have an impact on the historical relation to 'nature' via the therapeutic use of natural elements, applied in the field of chronic symptom management.

The aim was to further explore the effects of traditional Finnish winter swimming and to get an idea how suitable it could be incorporated as a natural tool for physiotherapeutic interventions in treating chronic pain. The objective was to summarize existing primary research via a Systematized Literature Review to form a reliable source of evidence, giving answer to the research question: "How does regular winter swimming affect chronic pain conditions?"

For better understanding, a thorough theoretical framework, backed up by evidence-based research, informed about the tradition and effects of water therapy and winter-swimming, explained pain as a process, discussed how relevant the latest suggested pain-management options are and shared first insights of blue exercising and the incorporation of winter-swimming into a treatment plan by discussing what impact the environment has on human health and vice versa, all in the context of physiotherapy. The framework cannot be considered as a manual guide for winter-swimming.

For the Systematized Literature Review, the topic was pre-searched, a proper search query was identified and the data base SAMK FINNA was used, which provides scientific articles from several other data bases. Free full-text, peer-reviewed, English articles were screened by considering relevant inclusion and exclusion criteria. The remaining articles were assessed by using the PEDro-Scoring Method and valuable data was extracted and analyzed. The whole process was following strict guidelines to ensure the validity and reliability of the work.

The results of this work showed that winter swimming can improve general well-being and that there is a correlation between winter swimming and pain reduction. However, these data could not be generalized in relation to the effect of winter swimming on chronic pain. More specific studies on this topic were recommended.

Keywords
Winter Swimming, Cold Water Immersion, Pain, Chronic Pain, Pain Management

"Ideally, we choose a treatment that might improve multiple issues."

Dr.Alan Pocinki

CONTENTS

1 INTRODUCTION

Chronic pain, as a symptom, which has partly been classified as an independent disease lately, affects more than 19% of people in Europe, often showing a tremendous negative impact on the quality of life and working life. It is thought, that almost half of those, who suffer from chronic pain, haven´t been satisfied with their treatment. A progress in the management of chronic pain is more than desired, for improving quality of life and avoiding common side effects, including several functional disabilities, fatigue, depression, anxiety, disruptive sleep, digestive problems, sexual dysfunctions to mention a few. (Breivik et al., 2006)

Not only disability, disease or pain conditions are associated with great distress in our everyday life, but as well imbalances in our environment can impact humans' well-being in a negative way. The degradation of our environment disconnects us from it and contributes to serious health problems, often leading to further receding. It is the responsibility of every health care practitioner to expand our knowledge about the relation of health and environment and to adjust our actions according to that. One counteracting option would be to use nature-based resources and treatments in physiotherapy with great care, considering the positive effects nature can offer for our health.

According to a study from Finland, regularly performed short cold-water immersions resulted in altered catecholamine levels, associated with pain and inflammation, fatigue and mood change and traditional winter-swimming, practiced widely in Finland and abroad, could therefore possibly be interlinked with various diseases showing these symptoms and might offer an appropriate new tool being used in physiotherapy (Huttunen et al., 2004, p. 140).

2 AIM AND OBJECTIVES

The aim of this thesis is it to further explore the effects of traditional Finnish winter swimming and to get an idea how suitable it could be incorporated as a tool for physiotherapeutic interventions in treating chronic pain.

The objective is to summarize existing primary research via a Systematized Literature Review to form a reliable source of evidence, giving answer to the research question: “How does regular winter swimming affect chronic pain conditions?”

For better understanding, a thorough theoretical framework, backed up by evidence-based research, informs about the tradition and effects of water therapy and winter-swimming, explains pain as a process, discusses how relevant the latest suggested pain-management options are and shares first insights of blue exercising and the incorporation of winter-swimming into a treatment plan by discussing what impact the environment has on human health and vice versa, all in the context of physiotherapy..

3 WATER AS THERAPY

3.1 History

Water Therapy thought to have healing effects already in times of the Greeks and Romans and have gradually developed from public baths into spas over the last century. Popular hydro therapists who emphasized the expansion of water therapy are for example Pastor Sebastian Kneipp (1821-1997) or Doctor Vincenz Prießnitz (1799-1852). (Reger et al., 2022) References about the use of cold as therapy from long ago can be found in the Edwin Smith Papyrus, an ancient text dated 3500 B.C. (Wang et al., 2006). Hippocrates, for example, was convinced that cold water therapy relieves fatigue (M. J. Tipton et al., 2017, p. 1336).

In natural medicine water therapies are still widely used and there is scientific evidence about the effects of water therapy on various body systems. In the scientific world the terms hydrotherapy or balneotherapy are more commonly used. (Mooventhan & Nivethitha, 2014) Hydrotherapy describes practices using all forms of water, such as ice, steam or water and is using alternations in temperature for causing a certain effect. Whereas Balneotherapy refers to baths enriched with carbonic acid, iodine or moor for creating a physical effect on the body. (Reger et al., 2022)

A relatively new term is thalassotherapy, which describes therapy with seawater. Such therapies have been around for years but are currently undergoing a reshaping and are increasingly being integrated into health care, among others, and continue to be popular as a tourist trend. In England, thalassotherapy has been recommended by doctors mainly for treating depression, neurological disorders, asthma and other pulmonary diseases. (Charlier & Chaineux, 2009)

3.2 Aquatic Therapy in Physiotherapy

A common hydro-therapeutic tool, used in physiotherapy is aquatic therapy. Aquatic Therapy means exercising in water by using the principles of hydrodynamics (Reger et al., 2022). The effects of hydrodynamics are valuable physical features of water, which are responsible for the various biological and physiological changes of the body. Buoyancy is the opposite of gravity and describes the tendency to float in water. (Wilk, 2013, p. 4) In water gravitational force is reduced and makes weightbearing movements easier (Thomson et al.). Advantages of buoyancy are the lower risk of falling and getting injured. Therefore, water therapy is a good way to train balance. Buoyancy also supports the training by compensating weak muscle strength and stretched positions can be held better. (Wilk, 2013, p. 4) Density is another feature of hydrodynamics. Water is by nature denser than air. The resulting increased resistance leads to a reduced movement speed and automatically strengthens the muscles isotonically. (Bates & Hanson, 1996) The hydrostatic pressure increases in water and leads to an increased circulation (Hall et al., 1990).

The body can as well benefit from the thermodynamic effects. Different temperatures are more suitable for some complaints and less for others. Table 1 below shows which activities are best at which water temperature. (Wilk, 2013, p. 5)

Table 1. Aquatic Temperatures and appropriate Activities (Becker and Cole, 2016)

Suitable Activities	Cold (10°C to 15°C)	Cool (26°C to 29°C)	Neutral (33.5°C to 35.5°C)	Warm (36°C to 38.5°C)
Postexertional recovery	+			
Contrast baths	+			+
Vigorous exercise		+		
Arthritis exercise			+	
Typical aquatic therapy			+	
Cardiac rehab			+	
Multiple sclerosis exercise		+		
SCI programs			+	
Parkinson's programming			+	
Relaxation				+

Water is generally excellent at storing heat or cold and at transferring it to the body, although, heat is transferred away from the body 25 times faster in water. A thermo-neutral temperature is a temperature that is not altering the body´s core temperature and is thought to be most appropriate for relaxation purposes. (Hall et al., 1990) Physiological effects might differ depending on the posture, as it can alter the body´s thermoneutral state. The thermoneutral state can as well be affected by different elements, such as duration/frequency, type of activity, temperature and should be part of each hydro-therapy session. (Bates & Hanson, 1996)

4 WINTER-SWIMMING

4.1 Definitions and Terms of winter swimming

Depending on the location, water temperature or purpose there are various terms used to describe different types of cold water immersions. According to the Suomen Latu

Outdoor Association, winter swimming (talviuinti) or cold-water swimming (kylmäuinti) refers to a regular swimming practice in natural water or indoor pools below 10 degrees Celsius. The unique term “ice swimming” is used to describe cold water swimming in a climate that provides freezing temperatures regardless of the season. Ice Swimming happens in a water temperature close to 0 degrees Celsius or below and is called “avantouinti” in Finnish language, whereas “jääuinti” (ice swimming) means long distance swimming in icy water as a type of extreme sport. After all, “avantouinti” is the traditional term commonly used here in Finland. (Suomen Latu Outdoor Association, 2022.) A visualized overview of the definitions and terms for winter swimming can be found in table 2.

Table 2. Definition and Terms for winter swimming (Suomen Latu Outdoor Association, 2022)

Winter Swimming (Talviuinti)	**Ice Swimming (Avantouinti)** **Traditional term**	**Cold Water Swimming (Kylmäuinti)**	**Ice Swimming (Jääuniti)**
Natural Water	Ice Water	Indoor Pools or Natural Water	Ice Water, long distance extreme sport
Temperature below 10° C	Temperature close to 0° C or below	Temperature around 8° C	Temperature below 5° C

4.2 History and Tradition of winter swimming in Finland

Winter swimming events have already been organized by Emil Järvö in Helsinki in the year 1923. After that, winter swimming has become a trend and several avantouinti clubs (winter swimming clubs) have been formed due to the great demand. By now there are more than 150 thousand people in Finland performing the sport regularly while the popularity and interest is increasing. (Suomen Latu Outdoor Association, 2022.) Nowadays, winter swimming is performed regularly in many Northern, Eastern and European countries, including Finland, Norway, Sweden, Denmark, Russia, Slovenia etc. (Knechtle et al., 2020).

A winter-swimming practice is started with a 10-15 min long warm-up for assisting the blood circulation and preventing vein strokes or cramps. The warm-up consists of exercises that are introduced from low intensity towards higher intensity and should not be fatiguing but stimulating. Winter-Swimming requires proper guidance before individual practicing can be continued. Traditionally, Sauna is associated with winter-swimming in Finland and may be used as a warm-up if an extreme temperature difference is avoided via cooling down, before entering the cold water. (Suomen Latu Outdoor Association, 2022.) In Finland cold water immersion has been performed together with their traditional sauna practice, which has inscribed on the Representative List of the Intangible Cultural Heritage of Humanity in 2020. These traditions have usually passed down through generations and have been described as a sacred space of nature, where everyone can clean their mind and body. (Unesco Intangible Cultural Heritage, 2022.) The average winter swimmer in Finland starts to practice late autumn, during winter and beginning of spring. While the water temperature fluctuates around 0°C during winter, immersions last for only 30-40 seconds, one or two times per practice and about 2-3 times per week. (Suomen Latu Outdoor Organisation, 2022.)

4.3 Winter Swimming as a sport

At the beginning of 1980 the hobby of winter swimming developed into a national sport and 1989 the first Finnish Championship in winter swimming has been held in Tampere (Suomen Latu Outdoor Association, 2022). In the year 2009 the International Ice Swimming Association (IISA) has been born, counting 73 member-countries and Ice Swimmers from 43 countries. IISA´s vision is it to become a winter Olympic sport one day by implementing Safety and Integrity as motto for the sport. The association holds competitions for women, men and disabled, covering swimming distances from 50 – 1000m in all strokes and for additional other categories such as Ice 7s, Ice Zero or Extreme Ice Mile. (IISA,2022.)

Despite the popularity as a sport, it has been observed that more than half of those who swim regularly say they do it for their health, primarily to minimize pain, rather than to compete (Huttunen et al., 2004, p. 143). Due to the more and more increasing

popularity of winter-swimming, further research into individual reactions to cold water is strongly encouraged (M. J. Tipton et al., 2017, p. 1335).

4.4 Physiological responses and effects to cold water

Previous studies on the effectiveness of winter swimming point out that responses to cold are differing and are dependent on individual factors as well as the intensity of the cold exposure, for instance age, sex, diet, body composition, amount of fat tissue, fitness condition, state of health, number of swims, regularity, duration, water temperature, water flow, movement in water; Some of the physiological responses change if practiced regularly. (Makinen, 2010, p. 1047); Suomen Latu Outdoor Association, 2022.) Summarized, they have observed and researched an improved functional capacity and alertness in cold conditions, an increased metabolism, the activation of brown fat, a reduction in blood circulation in inflammatory areas, a raise of pain threshold, an increased mental state resilience as well as a general mind-calming and refreshing effect (Suomen Latu Outdoor Association, 2022). A synoptical overview of physiological effects can be found in Table 3.

In a four-month study in 2004, researchers tried to find out what effect regular winter swimming had on the mood of the subjects and were able to determine a significant reduction in tension and fatigue, as well as an improvement in the general state of mind (Huttunen et al., 2004, p. 140).

Additionally, it was also pointed out that winter swimming might provide a social environment and form relationships for preventing loneliness during the dark wintertime in the North (Suomen Latu Outdoor Association, 2022).

Table 3. Physiological effects of winter swimming (Huttunen et al., 2004; Makinen, 2010 and Suomen Latu Outdoor Association, 2022)

Skin
• temperature drops, cold sensation, skin colour changes, reduction of dry skin
Circulatory System
• Increased Blood Circulation of internal organs • Variability in Blood Pressure (can cause dizziness) • increase in blood antioxidant levels • increase of heart rate
Hormone System
• Hormon Release from hypothalamus leads to Hormon Activation in pituitary gland (sense of pleasure, rising pain treshhold, betaendorphin causes addiction) • Adrenaline release from adrenal gland and Adrenaline Balance (blood flow stimulation, increased heart rate and decreased blood volume) • Cortisol release from adrenal gland (stress tigger) • Noradrenaline Release (Blood Vessel Contraction, decreased blood flow, decreased heat transfer)
Nervous System
• Activation of sympathetic nervous system
Muscular System
• Lack of oxygen in muscles (painful sensation)

4.5 Cold Adaptation as major effect

The immersion into ice-cold water leads to a stress reduction in the body, which changes the functions of the autonomic and central nervous system and among other things activates or balances the formation of certain catecholamines like noradrenalin or plasma adrenaline (Huttunen et al., 2004, p. 144).

One major benefit of a regular winter swimming practice is the adaptation to oxidative stress, meaning that the body learns to withstand stress factors, such as the cold water (Huttunen et al., 2004, p. 144).The process of cold adaptation in humans include cardiovascular, endocrinological and metabolic responses and are dependent on a regular practice (Makinen, 2010, p. 1047). A regular activity refers to 2-4 swims a week continued for several months and according to Pirkko Huttunen´s research the first effects are recognized after 2-4 weeks of daily practice and disappear when winter swimming is stopped (Huttunen et al., 2004).

During the process of cold adaptation muscle vibration/shivering starts to delay, the heat insulation improves and heat donation decreases. The body´s metabolism does

not only adapt to the cold but also to occurring temperature fluctuations. While stress hormones increase at the beginning of the winter swimming practice, they fall during a regular practice. The function of the sympathetic nervous system is balanced after the strong activation of the initial immersion. The metabolic responses, that are responsible for the energy regulation in the body, change. (Suomen Latu Outdoor Association, 2022.)

5 SAFETY IN WATER THERAPY

5.1 Contraindications and Limits of Water Therapy

According to the Australian Physiotherapy Association there are various conditions that require a pre-screening before attending to aquatic or hydrotherapy sessions. This includes all kind of cardiovascular and respiratory conditions, certain skin diseases, wounds, hear or vision impairments, menstruation, pregnancy and colostomies, epilepsy and swallowing difficulties and all kind of acute inflammatory conditions, infections, cognitive impairments, heat- or cold sensitivities and behavioral disorders or fear of water. As absolute contraindications conditions such as all kind of infections with airborne particles, open and unhealed wounds, urine or fecal incontinence and bladder infections are listed. (Larsen & Harrison, 2002.)

Some sources suggest that moving in cold environment is safe, anyhow it is often associated with an increased risk of injuries. This is partly due to an often-slippery ground, as well as a decrease in muscle flexibility and coordination. Usually, people who perform physical activities outdoors have a frost limit around -20°. In chronically ill people the frost limit might be much lower. (kylmäinfo, 2022.) Thermal responses are highly individual and therefore it is nearly impossible to prescribe limits, as many variables may interact (Michael Tipton & Bradford, 2014). Certain diseases such as cardio-vascular, respiratory, skin diseases, diabetes or Raynad effect are classified as

cold-sensitive diseases and require a clarification from physician whether the practice of winter-swimming is suggested or not (Suomen Latu Outdoor Association, 2022).

5.2 Hypothermia

In addition to that another risk factor is the heat transfer pattern of the human body in water, which differs from the one on land, meaning that in water the body releases 25 times more heat than in air. The exposure to cold water is therefore less than on land. (Suomen Latu Outdoor Association, 2022.) The worst consequences of a too long exposure to a cold environment are frostbites or hypothermia, which in rare cases may even lead to death (kylmäinfo, 2022). Hypothermia describes the decrease in body temperature which is divided into the three different stages of mild, moderate, and severe hypothermia, which are visualized in table 4 (Suomen Latu Outdoor Association, 2022).

Table 4. Stages of Hypothermia (Suomen Latu Outdoor Association, 2022)

Stages of Hypothermia	Body Temperature
Mild Hypothermia	34-35 °C
Moderate Hypothermia	30-34 °C
Severe Hypothermia	Below 30 °C

Hypothermia usually only happens in correlation with an accident. Anyhow, symptoms of mild hypothermia, such as chills/shivering or decreased physical or mental performance might occur during a winter-swimming practice and need to be taken seriously and better prevented, as vital signs are slowed down in cold water and may not show the real state of being. In general, during the practice of winter-swimming Safety requires the highest priority. Table 5 shows how fast you can find yourself in a life-threatening situation. (Suomen Latu Outdoor Association, 2022; kylmäinfo, 2020.)

Table 5. Timeframe of life-threatening situations (Suomen Latu Outdoor Association, 2022)

Water temperature	Drowning	Death
0	Less than 15 min	15-45 min
0-5	15-30 min	30-90 min
5-10	30-60 min	1-3 hours
10-25	1-2 hours	1-6 hours
15-21	2-7 hours	2-40 hours
21-27	3-12 hours	3 hours---

5.3 Autonomic Conflict

While many studies have looked at thermal responses only, it is now highly recommended to look beyond that. Observations in the USA Triathlon fatality Incident Study from 2012 demonstrate that deaths occurring during the swim happen more likely due to cardiac arrest than hypothermia. (Michael Tipton & Bradford, 2014) Cardiac problems occur more often during competition in form of cardiac arrhythmias and are thought to be associated with a pattern called ´autonomic conflict´, in which the sympathetic and parasympathetic part of the autonomic nervous system react co-activated (Michael Tipton & Bradford, 2014); (Shattock & Tipton, 2012). The onset of arrythmias is dependent on many factors including the time it takes the heart muscle to contract and then recover or as well additional triggers apart from the cold water, such as emotions of anger or stress, like it might be the case in competitions (Shattock & Tipton, 2012).

5.4 Prevention of Injuries

Because of the individual responses one can have during cold water immersions, individual risk factors and the persons individual medical history has to be considered before starting this new activity and professional guidance by winter swimming instructors or medical professionals should be used, for being introduced to supportive

equipment, the ideal environment, proper execution of the sport including warm-up´s and breathing techniques as well as how to behave after the immersion and how to support colleagues if practicing together or in emergency situations. The person who is practicing winter swimming should feel encouraged to listen to her/his own rhythm and pace and accept individual limits at any time. (Suomen Latu Outdoor Association, 2022.)

6 ENVIRONMENT AND HEALTH

6.1 Relationship between environment and health

To date back once again to the early history, we can find information about the impact of the environment on our health. For instance, in Hippocrates chapter, “Airs, Waters Places” he discusses the concepts of the four humors and talks about what effects the environment has on the human body. However, Hippocrates was convinced that illness is not only dependent on the individual body but as well on external factors, such as territory, climate and seasons. (Jouanna, J., & Allies, N., 2012, pp. 155–172)

For example, recent studies have shown that there is a growing awareness of how important nature is for human health, but also how much it depends on ecologically healthy nature (Varanasi et al., 2021, p. 2). Several environmental challenges, such as biodiversity loss, plastic pollution, air pollution, deforestation, sea level rise, ocean acidification can affect humans health. Global warming plays a huge role as well and the consequence of each event is a complex interplay with each other and all affected species. (Robinson, 2022.)

6.1.1 Ecological Health

Climate Change, for example, manifests itself through increased weather conditions, such as severe storms and flooding, extreme heat waves, especially in Europe and the Middle East, drought, and biodiversity loss. This leads, for example, to an insufficient supply of nutrients, which mainly affects infants and children, or to a strain on the cardiovascular system in the elderly population. The development of infectious diseases is also promoted by the changed climate. (Watts et al., 2019)

The previously mentioned effects of air pollution on the heart and lungs are additionally amplified by climate change, and at the same time, the main cause of air pollution, namely the use of fossil fuels, contributes negatively to climate change. The

healthcare industry is responsible for approximately 4-6% of global emissions. (Watts et al., 2019)

Similarly, many ecological processes interact and are dependent on each other. If, needed ecosystem services, such as clean water, natural landscape, stable climate, plants, animals, and all other organisms are neglected and threatened, severe environmental problems like biodiversity loss will be negatively amplified (Headrick, 2021, p. 478).

6.1.2 Environment-related diseases

The most important environmental factor responsible for the development of diseases is air pollution, followed by noise pollution (*Air Quality in Europe*, 2019, p. 10). Chemicals play a significant role, too, especially in the development of chronic diseases. Although, the synergistic interaction of different chemicals and the effects of some chemicals on health are relatively unexplored at present. However, according to a WHO estimate, about 2.7% of global deaths are thought to be due to chemical exposure. Drinking-Water pollution and contaminated bathing waters can have a negative impact on health. The EU has very good constant water quality, but some pollutants are not monitored. For example, the release of antibiotics via sewage treatment plants, poses a threat to health as it causes bacteria to become resistant to antibiotics. (European Environment Agency, 2019)

Cardiovascular Conditions, Respiratory Infections, Diarrheal Diseases and Malaria are listed as a high burden diseases attributed to the environment, but as the best preventable environmental-related diseases (Prüss-Üstün et al., 2016, pp. 18–22).

In 2012, more than 600000 deaths were attributed to environment-related diseases across the European Union, with Norway having the fewest cases at 9% (WHO, 2016) Worldwide 22% of all deaths, in numerically 12.6 million deaths, are attributable to the environment (Prüss-Üstün et al., 2016). According to the World Health Organization, in 2012, 20 million healthy life years were lost across the EU due to environment-related diseases (WHO, 2016)

6.1.3 Benefits of green and blue environment on the human body

Already 2005 a study suggested that access to exercise in green spaces would not only provide health benefits, but also be an economic benefit. They mentioned that exercises in green spaces have more positive impact on cardiovascular and mental health than exercise alone. (Pretty et al., 2005) By expanding usable green space, the global pain burden could be reduced as well (Stanhope et al., 2020).

The Marine Pollution Bulletin recently has published an informative article about blue space exercising. The researchers of this article mentioned three main effects that coastal areas, beaches, lakes and the like, have on humans, namely increased physical activity, increased sense of community and stress reduction. Currently, a national network to promote Blue Gym Activities is also being created, in cooperation with the Universities of Exeter and Plymoth (Depledge & Bird, 2009) .

The European Environment Agency also summarizes the most important effects of green and blue spaces on human health. They list an improved immune function, enhanced physical activity, improved social cohesion, improved relaxation and restoration, which all leads to an improved mental health, improved cognitive functioning, reduced cardiovascular morbidity, less cases of diabetes type 2 and improved maternal and fetal outcomes (European Environment Agency, 2019).

And in several other studies they have found various positive effects that green spaces and blue spaces have on the human organism. Highlighted were again improved mental health, more vitality, less stress, improved fitness levels and a decrease in obesity. (Alcock et al., 2014); (Callaghan et al., 2021); (Lachowycz & Jones, 2011); (Gascon et al., 2017)

In general, fresh water is an essential medium for human health and well-being. It provides us with nutrients through fish, seaweed, and fresh drinking water and apart from the health effects on human health it is, as well, needed for the proper irrigation of crops or other plants. In addition to that, water serves as a natural regulatory system, counteracting global warming. (White et al., 2020, p. 1)

Nevertheless, it is recommended to do further research about what impact green and blue spaces have on human health to be able to show effects more detailed and in relation to certain conditions (European Environment Agency, 2019).

6.2 Responsibility and Participation

For fighting the most burdensome environmental issues, namely, climate change and air pollution, the WHO suggests and introduces four wide categories. They highlight monitoring and reporting of progress, knowledge enhancement, the continuation in capacity building of health systems and the promotion of awareness raising. This requires a multi-professional approach, including the branch of healthcare. (Director-General, p. 7)

What comes to ocean health, there is a need for our society to promote desirable interactions between humans and the ocean for being able to tackle the current sustainability issues confronting ocean and human health. (Nash et al., 2021, p. 3)

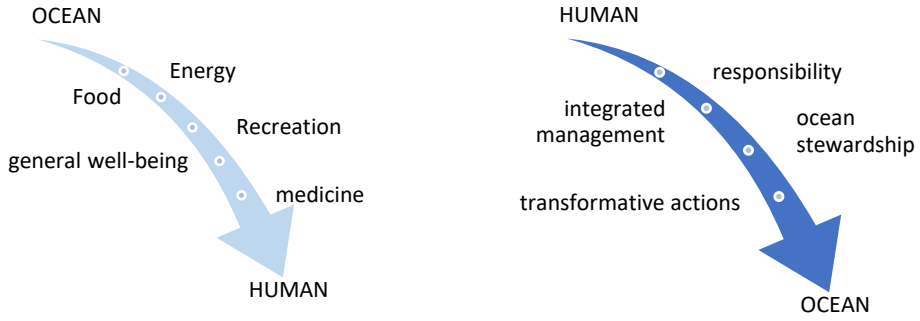


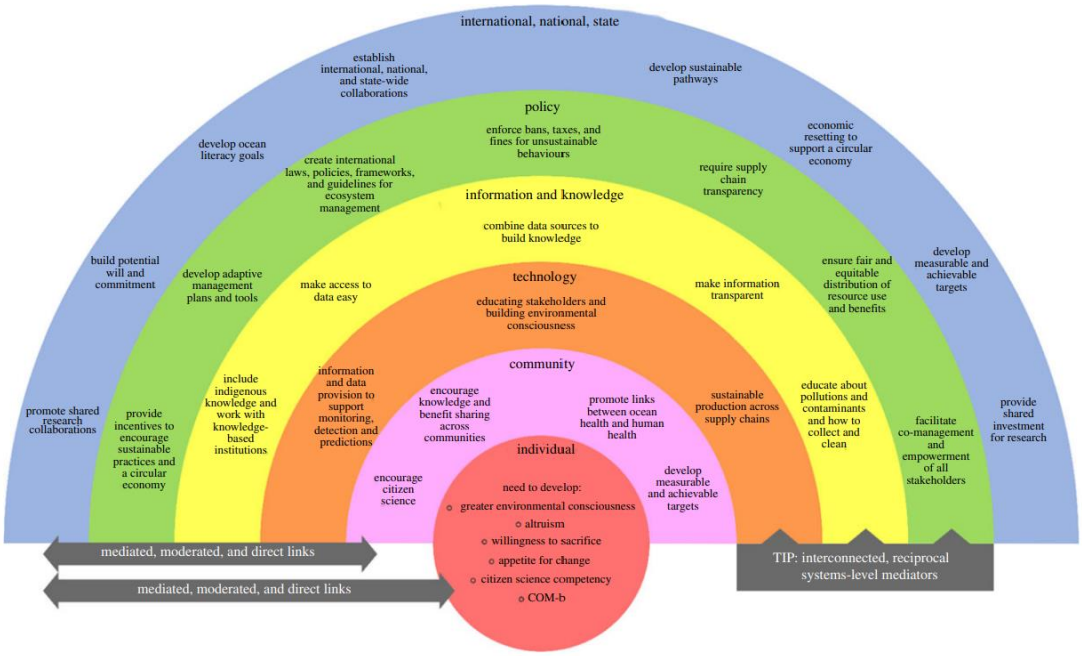
Figure 1. Interaction between human and ocean health (Nash et al., 2021, p. 3)

Desirable interactions count an integrated management and a responsibility for ocean stewardship in one direction and the use of resources such as seafood, energy, recreation, medicines, and general well-being into the other direction. The more the demand of resources in our growing population is rising, the more humans must counteract. (Nash et al., 2021, p. 4)

The knowledge about our oceans is increasing, anyhow there is a significantly disturbing gap between the communication, communication behavior between scientists and policy makers as well as citizens and the alignment of values. What is needed is a multi-dimensional approach that includes integrative management, multiple sectors and cultures and is inviting participation. (Salas et al., 2022, p. 2)

Transformative actions can be implemented by decision makers in the form of narrative future scenarios, which show a predictive outcome of certain actions. This approach is helpful for the achievements of set goals (Nash et al., 2021, p. 5). A showcase of such an implementation is the Future Seas project, in which international partners from different disciplines create narrative future scenarios by analyzing and researching their implementation (Salas et al., 2022, p. 2).

A study from 2022 introduced the socio-ecological model, seen in picture 1, for identifying the need for change in our society in relation to ocean health. The influence of different levels on the ocean was thus determined and suitable actors were woven in to counteract this. (Salas et al., 2022, p. 5)



Picture 1: The socio-ecological model applied on ocean health (Salas et al., 2022, p. 5)

Not only from early historical and environmental related scientific sources we may find relevant knowledge for facing current global health challenges well from indigenous knowledge, which has been recognized in the scientific world with growing respect. (Varanasi et al., 2021, p. 5) The international journal of environmental research and public health has started to collect and publish articles about the importance of Marine ecosystems on human health and well-being. Several articles imply that it is no longer a question of whether a multidisciplinary approach makes sense, but rather how the various inputs, including indigenous knowledge and cultural aspects are balanced and carried out. (Lioret & Maycock, 2021.)

Cultural aspects have already been highlighted in a 2009 research project, which concluded that cultural factors and health education must be integrated into the maintenance work of all facilities that supply us with water to achieve sustainable water management. This applies to both developed and developing countries, as we can all learn from each other. (SCHELWALD-VAN DER KLEY, 2020, vii.-viii.)

6.3 Water quality and effects of recreational activities on water

The member states of the EU are obliged to regularly check the water quality of bathing waters and to initiate countermeasures or remedial measures in case of non-compliance with the quality standard. Bathing waters in Europe, of which around 22000 are monitored, showed excellent status in 2019. The best water quality in Europe is found in Cyprus, Austria, and Malta, followed by Greece and Croatia. Only 1.3% showed poor quality. (European Environment Agency, 2019, pp. 95–97)

Causes of poor water quality are usually pollution from poorly protected sanitary facilities, cesspools, waste, or the use of sunscreens with toxic effects (European Environment Agency, 2019). Contamination impacts humans, as well as ecological health. Increased nutrient enrichment (eutrophication), for example by using fertilizers in agriculture, can lead to increased algae growth. This can cause serious intestinal infections or respiratory diseases. (European Environment Agency., 2018)
Furthermore, according to several studies, good water quality leads to increased and more satisfied use by guests (Hanley et al, 2002; Breen et al,2017).

6.4 Environmental Physiotherapy

The Environmental Physiotherapy Association, who acts as the first international community in the field of physiotherapy, research and education, believes that ecological practice and thinking should be an essential competency of physical therapy, meaning that human health interacts with and is interdependent on planetary health. This fundamental belief will lead to a more positive, valuable, and most importantly, environmentally friendly practice implementation in the future (Environmental Physiotherapy Association, 2022).

The EPA Network welcomes environmental and health - interested parties from a wide variety of industries, always with the goal of bringing physical therapy and the environment closer together, to share direction, understanding and continuous growth. In addition to active physical therapy practice, members are also active in research and education. The implementation of sustainability in the profession, based on the UN goals has a high priority, as well as a supporting contribution to policy development in relation to physiotherapy and beyond. Examining one's profession, openness, as well as critical thinking contribute helpfully to sharing ideas and implementing them through the EPA platform. (Environmental Physiotherapy Association,2022.)

Furthermore, they created the Environmental Physiotherapy Agenda 2023 with the aim "To ensure that every student beginning entry-level physiotherapy education from 2020 onwards will have education regarding the relationship between the environment, human health and functioning, and how this pertains to physiotherapy as part of their program" (Environmental Physiotherapy Association,2022.)

7 PAIN

7.1 Pain Process and Functions

The origin and perception of pain can be physiologically explained in such a way that harmful sensations are perceived by the body and transmitted to the brain via special receptors, called nociceptors (Garland, 2012). The process is called nociception. The 4 steps of nociceptive processing, namely, transduction, transmission, modulation and perception, are explained in figure 2 (Serpell, 2011, pp. 10–17).

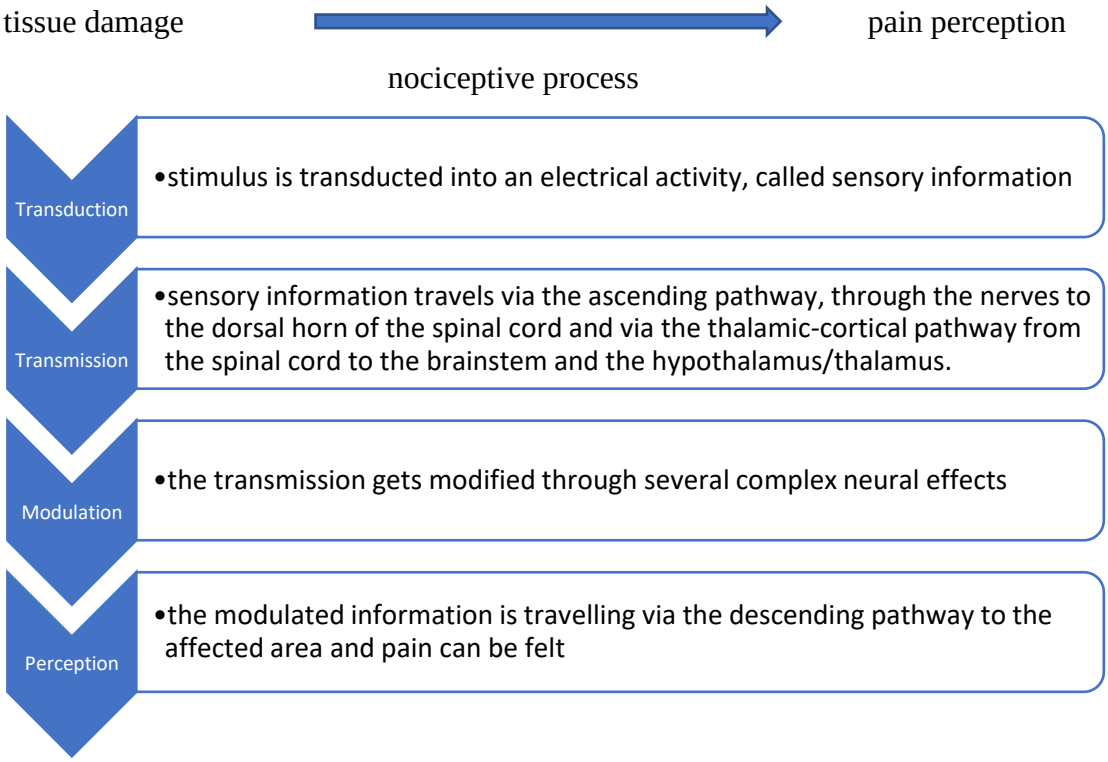


Figure 2. Steps of nociceptive process (Serpell, 2011, pp. 10–17)

The nociceptive process often occurs unpredictable and non-linear, which means that nociception does not always result in pain perception. As well, pain processes do not always occur consciously, despite the damage. At the same time, pain can occur without any tissue damage being diagnosed. (Garland, 2012)

Anatomical areas and organ systems that are involved into the process of pain are the peripheral nervous system and the central nervous system including the brain and the spinal cord with its nerves and neurons (Woller et al., 2017).

It is already known from previous studies that the brainstem has an influence on chronic pain processes, but current neuroimaging techniques cannot provide accurate imaging, so that advanced neuroimaging techniques with a focus on brainstem research are being sought. Due to its size and location, it requires multiple neuroimaging techniques, for getting precise results. A progress in this field of studies would be a successful step in pain research. (Napadow et al., 2019)

The nociceptive process works as a protection system for preventing injuries or damage, as it sends sensory information to our brain. The pain perception gets facilitated via the descending pathway during the modulation phase (Latremoliere & Woolf, 2009). The human body is equipped with an innate natural pain reduction system which can reduce pain through neural inhibition. In this case, the pain gets inhibited via the descending pathway during the modulation phase. The main neurotransmitters that are involved in the inhibition process are endogenous opioids, noradrenaline, and serotonin. (Stamford, 1995)

7.1.1 Pain threshold and pain tolerance

Factors such as pain tolerance and pain threshold need to be considered in connection with pain experiences. They also form an important reference point in science. Pain threshold describes the minimum stimulation needed to elicit pain, while pain tolerance describes the maximum stimulation that someone will tolerate. A low pain threshold is also referred to as allodynia, an increased pain perception as hyperalgesia.

Changes in the pain tolerance or the pain threshold are among the usual malfunctions in connection with the experience of pain. (Serpell, 2011, pp. 3–4)

7.1.2 Nerve Sensitivity

Repeatedly or particularly intensive pain gets classified as more dangerous by the body´s somatic-sensory system, to which it reacts hyper-vigilantly. Such cases may lead to the development of a higher pain threshold or a lower pain tolerance. The process of this maladaptive form of hypersensitivity is called neuro plasticity. (Latremoliere & Woolf, 2009) Neuronal plasticity means that the nervous system can reorganize and thus change its response to certain stimuli. This can be used positively in the recovery of certain injuries and is currently being intensively researched and means that nerve-sensitivity can be changed. (Mateos-Aparicio & Rodríguez-Moreno, 2019)

Central sensitization describes a process in which neural information is increasingly sent out within the central nervous system. This leads to increased pain intensity. Central sensitization is associated with chronic pain, and early studies have explored the link between CNS-related pain and body awareness, suggesting that such an approach, that includes adaptive body awareness techniques could potentially improve a personalized pain treatment. (Colgan et al., 2022)

Nerve sensitivity can be analyzed and understood through medical history, questionnaires, sensory testing, or what is known as quantitative sensory testing, such as the QST battery (Arendt-Nielsen et al., 2018); (Finnerup et al., 2016). Some of the standard tests used so far are less suitable and studies recommend further development of such assessment tools. Neuroimaging and electrophysiological tools have been proposed. (Alomar & Bakhaidar, 2018)

7.2 Pain classifications and Terms

Pain can be classified based on its cause. Nociceptive Pain occurs due to tissue damage and can further be categorized into somatic pain affecting muscles, bones and skin tissue and visceral pain affecting internal organs. Neuropathic Pain occurs due to damaged nerves or parts of the nervous system or in abnormalities of the sensory function. Psychogenic Pain occurs due to an underlying psychological disorder, commonly depression. When the cause of pain is not known it is referred as Idiopathic Pain. (Serpell, 2011, pp. 5–7)

The technical term for persistent pain sensitivity is hyperpathia. If the body shows an elevated sensitivity to a certain stimulus, it is called Hyperaesthesia. (Serpell, 2011, pp. 3–4)

Chronic Pain is defined as a disturbance of the central nervous system. It is pain that persists beyond the usual duration of pain (Tracey & Bushnell, 2009). In chronic pain patients, the neurotransmitters, that are involved in the natural pain inhibition process are lowered. Depression shows a similar decreased amount of these neurotransmitters and suggests a connection between the two diseases. (Yang & Chang, 2019); (Sheng et al., 2017); (Haase & Brown, 2015)

According to the current version of the International Classification of Diseases, chronic pain conditions with an underlying disease or tissue damage are classified as secondary pain, whereas primary chronic pain is classified as an independent disease. Examples for primary chronic pain are fibromyalgia or unspecific lower back pain. (Treede et al., 2019) Other characteristics of primary chronic pain are anxiety, a frustrated or depressed mood and a significant negative impact on the quality of life (International Classification of Diseases, 2022).

7.3 Pain Management

During a presentation for the The Bobby Jones Chiari & Syringomyelia Foundation from 2014, Dr.Alan Pocinki suggests an individualized and comprehensive treatment

plan for every patient with chronic pain symptoms, including limitations and goals of the treatment and he points out that an accurate diagnosis builds the first step in his treatment approach before the pain is getting addressed medically and complementary (Pocinki, 2014).

Self-efficacy and fear avoidance beliefs, together with pain intensity and pain duration, are equally, if not more, important factors in identifying the extent of some conditions. Dr. Alan Pocinki said that important components of a treatment might include in addition to exercises, education about daily activity adjustments, diet/fluid-intake, rest/sleep, stress-management. (Pocinki, 2014.) The above factors are visualized in figure 3 and 4 (Denison et al., 2004).

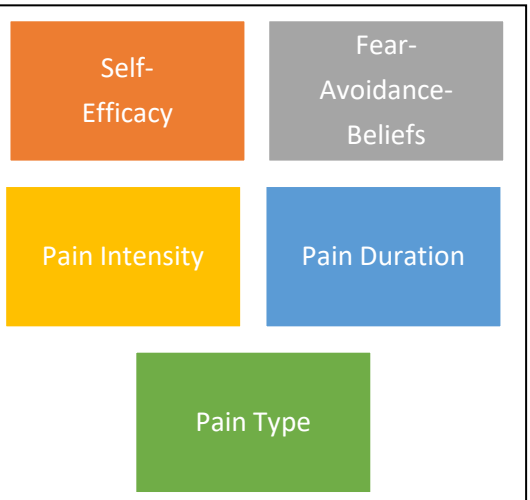


Figure 3. Factors to be addressed for identifying pain and other conditions (Denison et al., 2004)

Figure 4. Components of pain treatment (Pocinki, 2014

There are several physiotherapeutic and other health-professional tools available for addressing the various symptoms accompanying chronic pain. However, in any case, the treatment plan should be created by means of the bio-psycho-social model to include all aspects of the pain condition. . (Gatchel et al., 2007, p. 607)

7.3.1 Bio-psycho-social aspects and a holistic approach of pain management

Thinking of the biomedical knowledge explained in this thesis, it was mentioned that the pain process cannot be understood as linear process. Therefore, the bio-psycho-social model was created and if implemented on chronic pain, improves the understanding of the disease through creating a picture that involves physical, psychological and social aspects and their interaction with one another. There are various theories explaining how the three factors are interconnected and how they affect the healing process positively and negatively. This bio-psycho-social approach encourages to see pain as an individual and unique expression or experience. (Gatchel et al., 2007, p. 607) The model is widely accepted and used, however, there are many theories woven in or standing next to this model. Pain Theories or Pain Management Theories such as the gate control theory, the neuro-matrix theory or the lately introduced and suggested extension to the BPS model, the enactive approach.

A study from 2019 introduces this approach by estimating the current BPS model as non-adequate and its implementation rather fragmented, too dualistic and the boundaries between the physical, social, and psychological aspects of the BPS model as artificial. The conceptualized version of the BPS model, seen in figure 5, describes pain as “a relational and emergent process of sense-making through a lived body that is inseparable from the world that we shape and that shapes us. It includes 5E-aspects such as embodied, embedded, enacted, emotive and extended. (Stilwell & Harman, 2019) This model fits wonderfully into the approach of this thesis, which builds on a holistic, as well as natural view, including the environment into the therapy.

Including the environment in the therapeutic approach also means paying attention to past experiences. Paquet et al. concluded that past pain experiences influence the present pain modulation. (Paquet et al., 2017)

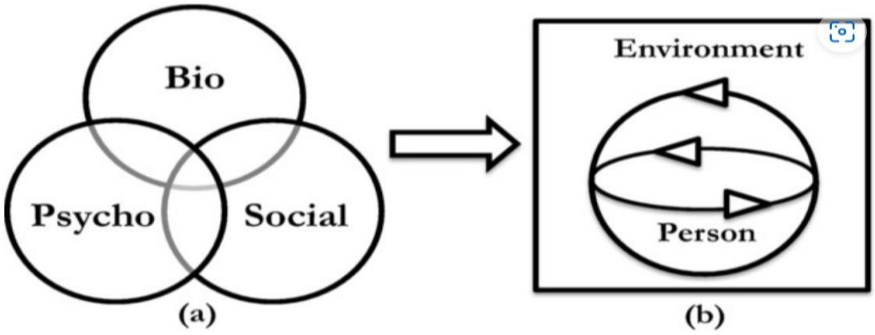


Figure 5. Conceptualized version of the biopsychosocial model (Stilwell, P., & Harman, K., 2019)

The bio-psycho-social model is as well sex-related. A recent study mentioned a higher expression of hypersensitivity in women and differences in cognitive and social factors between women and men. Anyhow, together with a shift in paradigm, they found it hard to draw any conclusions and recommend to focus on the validity of such research, as it is an understudied but important topic. (Racine et al., 2012)

7.3.2 Undiagnosed and untreated chronic pain

Regardless of gender, pain sensitivity should always be taken seriously, as discredit and staying undiagnosed leads to a row of severe consequences. Tosas M.R. enumerated self-doubt, distress, increased analgesic intake, denied sick leave behavior as main consequences. (Tosas, M. R. 2021.) Health sociologist Arthur W. Frank also highlights how important acknowledgement is for the patient, to heal properly (Frank, 2013).

Staying undiagnosed means that you won´t get the symptom relief either and several alternative treatment trials might interact with each other, causing more harm (Tosas, 2021). An emphasized care for patients with untreated chronic pain should be advocated (Zonneveld et al., 2013).

Letting pain untreated and chronic pain in general may increase stress hormones and lead to neurotransmitter deficiency, which can cause fatigue, depression and other

related symptoms (Kang et al., 2021). Dr. Sylvia Gustin explains, that emotional dysregulation caused by pain cannot always be treated by medication and can even hinder the treatment (Gustin, 2021).

The quality of life for patients with unexplained symptoms is among the poorest of all patient groups and is mainly caused due to functional limitations that hinder them from participating in everyday situations. The demand for health care interventions is high and amounts to an average number of 6815 euros per year for one patient. (Zonneveld et al., 2013)

7.3.3 Physical Activity and Exercising

The national institute for Health and Care Excellence is convinced that exercise builds a core tool in treating all kind of conditions, including pain (*Osteoarthritis*, 2020).

People who are suffering from chronic pain, such as Fibromyalgia patients, tend to be less active and very often develop a fear of movement behavior. At the same time symptoms might worsen due to missing physical activity. If so and in any case of chronic pain, a slow adaptation to movement is recommended, starting with exercises the patient finds comfortable, aiming for the low end of moderate intensity. (Busch et al., 2011, p. 366)

Long term adherence builds an important but challenging goal in the treatment of chronic symptoms. A non-excessive load should be aimed to counteract this and tracking devices or exercise diaries can be beneficial for keeping up the motivation of the patient. (Tudor-Locke & Lutes, 2009); (Jones & Liptan, 2009)

Patients need to be educated, that early muscle soreness in the beginning of their physical activity journey is a natural response of the body. In general, physical activity is not likely to cause any harm to the body if the progress of the practice is followed and guided by a therapist. Physical activity can improve the overall functioning of the body and might decrease pain symptoms. Therefore, the quality of life can be enhanced. (Geneen et al., 2017)

8 THESIS PROCESS

8.1 Implementation of the Thesis

A thorough theoretical framework, backed up by evidence-based research, informs about the tradition and effects of water therapy and cold-water swimming, explains pain as a process, discusses how relevant the latest suggested pain-management options are and shares first insights of blue exercising and the incorporation of the environment into a treatment plan.

By presenting a systematized literature review, valuable data for analyzing the research question: “How does regularly performed traditional Finnish winter swimming affect chronic pain?”, was gathered. It has been used as a method for this study with conviction of being the most appropriate for conducting a comprehensive search about a relatively new topic as it requires a smaller set of eligible articles and is thought to be suitable for being used by a student on bachelor level who has little experience in research and fewer resources available.

8.2 Systematized Literature Review

Systematized Reviews are very similar to Systematic Reviews but are usually conducted by one person alone. It is therefore particularly useful for students. Scientific reviews can be very valuable, but equally misleading. Strict review methods are necessary to prevent bias and to ensure the validity of the work. The more rigorous the review methods, the lower the risk for misinformation. This is also particularly important, as in this case, when it affects evidence-based practice. (Sataloff et al., 2021)

Characteristics of a systematic paper are the clearly defined research question and the rigorous assessment and analysis of the research evidence, following the current standard guidelines called Preferred Reporting Items for Systematic Reviews and

Meta-Analyses (PRISMA). The guideline includes a list of 27 items that should be followed (Sataloff et al., 2021).

The study design, such as the pico-method, search strategies, study characteristics and inclusion and exclusion criteria, as well as their rationale, must also be stated. The applied characteristics, inclusion and exclusion criteria can be found in under paragraph 8.2.1. and in table 6 under paragraph 8.2.2. The selection process for articles and which methods were used to assess them, or why they were included or excluded, must be reported. The PRISMA flowchart can be used to present this information clearly. The applied version of the PRISMA flowchart can be found in table 7 under paragraph 9. (Sataloff et al., 2021)

8.2.1 Research Question and Pico Method

The PICO method is a helpful model format to define a clinical research question to filter out relevant information more easily and precisely (University of Illinois Chicago, 2022).

PICO refers to
P (Problem) – How do I describe the group of patients?
I (Intervention) – What main intervention or exposure am I considering?
C (Comparison) – What can I compare the intervention to? What is an alternative?
O (Outcome) – What can I hope to measure, improve or affect for the chosen? (University of Illinois Chicago, 2022)

and can then be formulated according to your research topic.
P – Winterswimmers suffering from chronic pain
I – Winter-Swimming
C – No comparison/control group
O – Winterswimming affects chronic pain in some way

According to the applied PICO, the thesis aims to find answers to the research question: How does regular winter swimming effect chronic pain conditions?

8.2.2 Search Terms and Inclusion Criteria

Table 6. Applied Study Characteristics, Exclusion, - and Inclusion Criteria and Search Query

Initial keywords (key concepts)	**Other search terms**	
Winter Swimming	cold water swimming, cold water, ice swimming, ice swimmer	
Chronic Pain	Pain, persistent pain	
Data Base	**Search Queries**	**Results**
SAMK FINNA	(“winter swimming” OR “cold water swimming” OR “ice swimming”) AND (“chronic pain” OR “persistent pain” OR “pain”)	91
Inclusion Criteria		
Time Frame	2000-2022	
Type of Literature	Full free text, peer reviewed articles	
Language	English	
Population	Humans	
Content	Winter swimming or Cold Water Immersion ranging from 0-15 degrees celsius	
Exclusion Criteria		
Population	- Athletes using cold water immersion - Animals	
Content	- Cold Water Immersions as post exercise recovery method - CryoTherapy (air)	

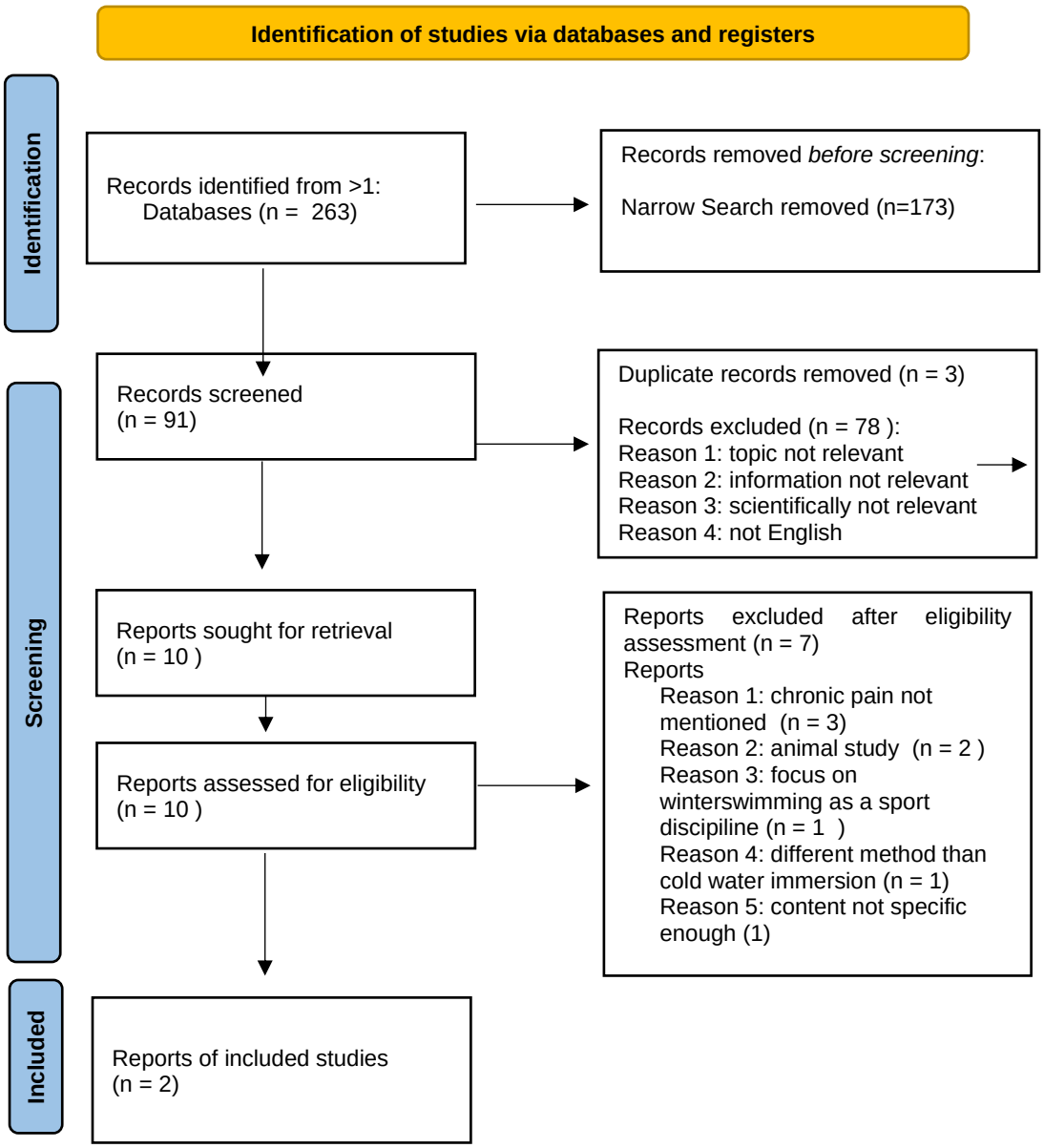
The data base SAMK FINNA has been used, which provides scientific articles from several other data bases. After pre-searching the topic of winter-swimming and chronic pain in different data bases and with different search queries, SAMK FINNA was seen to provide the most valuable information while the chosen search query provided relevant data as well. Full free, peer-reviewed English text articles writing about winter-swimming or cold-water immersion, when water ranges from 0-15 degrees Celsius, published between 2000-2022 have been included and exclusion criteria such

as athletes using cold water immersion, animals, cold water immersion used as post exercise recovery method and cryotherapy using air as a mean, have been defined, for getting narrowed results focusing on pain and winter swimming only.

9 RESULTS

9.1 Study Selection

Table 7. Applied PRISMA Model (Page, M.J. et al, 2020)



The initial search resulted in 263 records. After using automatic narrowing search criteria the search engine 173 records were removed and 91 full-text, peer-reviewed records, published in the time frame between 2000 and 2022 were left. All 91 records were screened and 3 duplicates and other 78 records were excluded, as in some haven´t been scientifically relevant, the information or topic has not been relevant, or the article was not in English language. 10 reports were sought for retrieval and assessed for eligibility. After the assessment 3 articles were excluded, as chronic pain has not been mentioned, 2 animal studies were excluded, and 3 more were excluded because they focused on wintersport as a sport discipline, they used different method than cold water immersion in their study or the content was not specific enough. The quality of the 2 remaining studies has been assessed using the PEDro Scale Scoring Method. Both, the study summary and the quality assessment can be seen in table 8 and 9 under the paragraph 9.2.

9.2 Quality Assessment

The PEDro scale is a method to assess the quality of clinical trials by answering 10 questions about internal validity. Each question answered with a yes means one point. A score below 3 indicates poor quality, a score between 4 and 5 indicates fair quality trials, and a score between 6-10 indicates high quality trials. (Pedro Organization, 2022.)

Table 8. PEDro Scale Scoring

Author	2	3	4	5	6	7	8	9	10	11	Score
J. Leppäluoto et al.	*	x	*	x	x	x	*	x	*	*	5/10
Pirkko Huttunen et al.	x	x	*	x	x	x	*	x	*	*	4/10

Table 9. Study Summary

Author	Article	Results / Conclusion
Pirkko Huttunen, Leena Kokko, Virpi Ylijukuri	Winter Swimming improves general well-being	Improvement of general well-being is a benefit induced by regular winter swimming
J. Leppäluoto, T. Westerlund, P. Huttunen, J.Oksa, J. Smolander, B. Dugué and M. Mikkelsson	Effects of long-term whole-body cold exposures on plasma concentrations of ACTH beta-endorphin, cortisol, catecholamines and cytokines in healthy females	The main finding was the sustained cold-induced stimulation of norepinephrine, which was remarkably similar between exposures. The frequent increase in norepinephrine might have a role in pain alleviation in whole-body cryotherapy and winter swimming. Norephinephrine showed significant 2-fold to 3-fold increases each time for 12 weeks after both cold exposures.

9.3 Effectiveness of regular performed winter swimming on chronic pain

The two chosen studies can to some extend be linked to the research question of how regular performed winter swimming does affect chronic pain.

In their 2004 study on the effects of winter swimming on the state of mind, Huttunen et al. found, among other things, that subjects suffering from rheumatism, asthma, fibromyalgia, and arthritis, namely about 40%, showed reduced pain or were able to tolerate it better after regular cold-water swimming. Additionally, the study indicates that the ability of cold-water adaptation positively counteracts states of tension and

fatigue and thus leads to a better general well-being. A total of 36 swimmers and 23 controls aged between 30 and 68 years participated and practiced winter swimming on average four times a week over a period of 4 months. Objective data for this study was collected at the beginning of the intervention in October and after the end of the intervention in January via the POMS questionnaire, subjective data via the OIRE questionnaire. The last also includes questions about somatic symptoms. However, factors concerning the state of mind could be indirectly related to pain management. About half of the subjects reported physical activity outdoors, which should be included as an influencing factor in the evaluation of the study.

J. Leppäluoto et al. conducted a study to find out about how long-term regular exposure to cold temperature influences pain alleviation. Over a period of 12 weeks, 10 female subjects were each exposed to winter swimming or an ice chamber three times a week. The water temperature was 0-2°C for the winter swimmers and the subjects were in the water for 20 seconds. Humoral factors were collected and statistically analyzed to measure the effects. A significantly increased plasma norepinephrine value was noted, which could be related to a reduction in pain. The results of the two control groups did not differ. Unlike previous studies, no habituation was observed, and plasma norepinephrine remained unchanged this time, suggesting that several small factors may influence the response of plasma norepinephrine. Such factors can be duration, water temperature, gender, age, etc. Furthermore, seasonal variations could also be responsible for the missing habituation in this group. No significant or relevant changes in stress hormones ACTH, beta-endorphins, adrenaline, cortisol or pro-inflammatory cytokines could be detected. The study was conducted on healthy individuals and the responses could therefore be different in patients.

10 CONCLUSION

Scientific data is present that regular cold-water exposure in the form of winter swimming can lead to pain reduction in some cases. Elevated blood levels of norepinephrine as an effect of a regular winter swimming practice are most likely

associated with pain alleviation. However, such data are sensitive to external and internal factors and physiological responses to cold water vary from study to study. It is not possible to generalize about the effects of winter swimming on chronic pain conditions. However, winter swimming leads to a general improvement in well-being and might influence pain tolerance and perception positively. Further, more specific studies are needed to understand the complex effects of an increasingly popular intervention on the healthy and diseased human organism.

11 DISCUSSION

As a chronic pain patient, personal and professional experiences in the field of chronic pain management, water therapy and first positive experiences in traditional Finnish winter swimming aroused the author's interest and led to the creation of the research question. The focus during the first phase of the thesis process was on the implementation of a case study related to a specific complaint in connection with winter swimming. This would have been appropriate as there is little literature available on the topic. However, due to a change in the laws for undergraduate students, the implementation of such an interventional study was not possible and the author opted instead for a Systematized Literature Review related to the effects of winter swimming on general chronic pain conditions.

The author was thus able to gather basic information from already researched studies. The methodology is helpful in this case to familiarize oneself in detail with a topic that is relatively new for physiotherapy and to gather sufficient expertise before investing more time in more extensive, interventional research. The method is also useful for gaining initial experience in scientific work as an undergraduate student and because other methods are more difficult to implement in comparison. Systematized Literature Reviews are among the most reliable methods in research, but also require rigorous review methods to counteract bias and avoid misinformation, especially in evidence-based physiotherapy practice. Review guidelines are therefore followed as strictly as possible and in a structured way to produce reliable results.

The Research Question was partially supported by solid evidence from the study results. The results of the present two studies cannot be generalized but show some interesting and valuable evidence that is relevant for further research purposes. Both studies mention an association between winter swimming and perceived or physiologically explained pain reduction, without explicitly addressing chronic pain conditions. Qualitative and quantitative data from non-included studies, as well as own experiences, support the hypotheses of both studies shown, but as mentioned, do not yet provide significant results in relation to chronic pain conditions. This conclusion may also be due to the author's inexperience in analyzing studies properly.

Several sources mention, that physiological responses after cold water immersions are easily influenced by external factors, and some responses change with regular practice. This makes detection of clear scientific results difficult and raises the question of why habituation of cold stimuli occurs in some individuals and not in others. A gender-specific deviation of reactions can also be detected and suggests that women have a different pain tolerance or pain sensitivity than men and react differently to social factors (Racine et al., 2012). This needs to be considered in further studies, among other things, because pain tolerance and pain threshold form an important reference point in science. (Serpell, 2011, pp. 3–4) Furthermore, it can be observed that chronically ill persons react more sensitively to cold stimuli (kylmäinfo, 2022). When implementing winter swimming as a physiotherapeutic tool, the author therefore recommends focusing strongly on the individual perception of the patient, as is usual in pain therapies, and to inform winter swimming newcomers about risk factors or to seek medical advice.

After the author had worked as a massage therapist for several years, was confronted with pain patients on a daily basis, and the demand for therapy could usually not be met sufficiently, as well as high-quality therapies were not affordable for everyone or could not be integrated into everyday life in terms of time, the author soon became interested in more active therapy approaches, which equally bring along the patient's own responsibility and minimize the dependence on the therapist. Studies also observed that many pain patients are severely restricted in their everyday life, social

life, and work life, which often leads to social withdrawal (Zonneveld et al., 2013). In addition, many chronically ill people are not sufficiently satisfied with the therapy they receive.

Some of the problematic aspects mentioned above could be positively counteracted by the winter swimming tool. Winter swimming requires a good portion of self-responsibility and body awareness, which can be improved through regular practice in winter swimming. From a therapeutic and medical perspective self-management is an essential aspect in treatments that require long term care, same as body awareness (Pocinki, 2014). Winter Swimming does not require much time in its implementation and can even be compared with a regular sauna bathing practice, at least in Finland. According to the Suomen Latu Outdoor Association, winter swimming promotes social contacts, and many practitioners are part of a community (Suomen Latu Outdoor Association, 2022). Winter swimming is not suitable as a solo practice due to the risk factors, to which a whole chapter of this thesis has been dedicated, and therefore promotes a sense of community among patients and is of economic importance as several patients can be cared for at the same time. The accessibility of natural bathing facilities in winter is in any case given in Finland, but in other parts of Europe it is strongly dependent on climatic and geographical conditions. Switching to indoor swimming sites is most likely necessary in some places to make the practice accessible for everyone.

Besides the effects of winter swimming on chronic pain conditions, the author, as a member of the environmental physiotherapy association, was also interested in whether and how winter swimming can be integrated into physiotherapy as a treatment tool in the context of blue exercising and how such an implementation could affect our environment and health. To what extent winter swimming has an impact on the environment depends strongly on the water quality of the respective winter swimming spot and its management and could not be analyzed by the author in this study across disciplines. However, the extremely good water quality throughout the EU lends itself to therapeutic options (European Environment Agency, 2019, pp. 95–97). The positive effects of therapies in green spaces, in or near the water, as well as the negative effects of a wrong handling of the environment, are, however, explained in numerous ways in

the theoretical framework and the preservation, improvement of the environmental quality is essential for our health maintenance. (Pretty et al., 2005) By expanding usable green space, the global pain burden could be reduced as well and exercise in green or blue spaces was seen to be more effective than exercise alone (Stanhope et al., 2020). Knowing about and acting according to the interdependencies of human health and environment, is no longer a choice, but an absolute need that affects and calls the entire population, but especially addresses healthcare practitioners in their responsibility.

The three topics of pain management, environmental protection, and scientific work were identified and presented by the author as extensive and complex. A multi-professional and holistic approach to addressing the issues of this thesis is required and successful implementation in a timely manner is probably not fully possible. However, small steps are very much feasible. The recently integrated extension of the bio-psycho-social model to bio-psycho-social + environment, for instance, supports the holistic basic idea of the author and points to first steps in the inclusion of the environment in therapy approaches (Stilwell, P., & Harman, K., 2019). The thesis offers many suggestions for further research on these topics. Some studies the author met during the process also reported the positive impact of winter swimming on depression. Depression is often related to central sensitization due to chronic pain and could therefore have a secondary positive or supportive effect on pain reduction. Chronic pain, according to the author, should not be considered in isolation anyway and the language used in physiotherapy, in relation to pain, should be chosen mindfully. For example, chronic pain very often involves physical but also mental aspects, and pain can therefore be looked at and treated through both pathways. Explaining the process of pain to the patient, by using the right terms and the right communication is as well helpful for creating a more holistic view.

The objective of this thesis topic, namely, to combine several topics and to summarize existing primary research to form a reliable source of evidence, was enormous for an undergraduate level and the implementation of the desired goals was very challenging in terms of time, not only because the author wrote a thesis for the first time, but also because it was written in a foreign language. Without passion, motivation, emotion

and staying power, the realization of this thesis would not have been possible. This thesis process has shown how enriching and important a multi-professional approach in all areas of life is to address the many interwoven issues facing our society and environment. The author was able to weave research skills, physiotherapeutic expertise from her studies and internships, as well as personal experience into the thesis framework. The systematized literature review helped to ensure a good quality of scientific work, to reduce the risk of bias and to increase the validity of the results due to the reasonably strict and structured guidelines. Results that cannot be generalized have less significance and, to some extent, reduce the validity of the findings, but at the same time they communicate that further research in this area is needed or encourage for further questions, and are therefore important. The theoretical framework of the thesis was written without structure from outside and most likely has structural and content errors due to the inexperience of the author. A clearer structure could have been achieved by implementing the systematized literature review as a first step before the theoretical content was fully elaborated. Another limitation of the thesis is the lack of a control group. Supervision was highly appreciated and necessary mainly as a guide to bring the focus back to what is relevant, not to digress and to gain self-confidence. During the whole process the author has been very critical in her thinking, which can be considered as a strength.

Finally, the thesis addresses the research question, intends to implement the defined objectives, provides answers, links different findings, and recommends solutions as well as next, further approaches.

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