Health of Icelandic fishermen - 2012

A follow-up study of physical activity and health

Eliths Freyr Heimisson

Lokaverkefni til M.S. –prófs í íþrótta- og heilsufræði

Háskóli Íslands
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Leiðbeinendur: Erlingur Sigurður Jóhannson og Sonja Sif Jóhannsdóttir

Íþrótta- tómstunda- og þroskaþjálfadeild

Menntavísindasvið Háskóla Íslands

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Ritgerð þessi er 60 eininga lokaverkefni til meistaraprófs við íþrótta- tómstunda- og þroskaþjálfadeild, Menntavísindasviði Háskóla Íslands.

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Foreword

This thesis is a component of a research-based Master of Science degree in sports- and health sciences at the University of Iceland. The thesis equals 60 ECTS points and is a quantitative follow-up study of the health of Icelandic fishermen which was done by Olafsdottir et al (2012).

Supervisors were Erlingur Sigurður Jóhannsson, professor at the University at Iceland and Sonja Sif Jóhannsdóttir, Risk manager at TM insurance. I would like to thank them for all the help and guidance that they have given me and I am ever grateful for it.

I would also like to thank all employees at The Icelandic Heart Association (Hjartavernd) for helping me collecting the data for the endurance and blood tests for statistical analysis.

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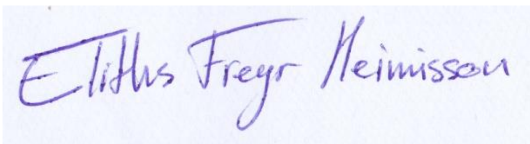
Júlíus K. Björnsson has my thanks for helping me with the analysis of the IQL questionnaire.

Lastly I would like to thank my little family. Without them a lot of this would not have been possible. Their support has been a cornerstone and a great spur for me.

It has been a great experience for me to measure the participants and work with doctors, and other healthcare personnel to collect the data. I recommend all master students to be involved in data collection and to connect with the participants as I have done in this study. Doing so will give the master student great experience and satisfaction as the student will be involved in the entire process of a study, from an idea, to data collection and lastly conclusions, and how complex these studies can be.

I expected to learn about what effect physical activity and nutrition interventions have on the health and physical activity adherence of participants in the long run. Also I wanted to learn about the effects of physical activity and lifestyle on health and well-being. Lastly I also had the expectations of learning about the work of research, especially data collection, statistical analysis and writing scientific articles. All of these expectations have been fully fulfilled.

Reykjavík, Iceland, 15.4.2015



Ágrip

Heilsa sjómanna - 2012

Markmið: Að kanna breytingar á fjölda heilsufarstengdra þátta íslenskra sjómanna á sex ára tímabili. Einnig var markmiðið að rannsaka langtíma áhrif hreyfingar- og næringaríhlutunar á hreyfingu og heilsufarstengda þætti íslenskra sjómanna.

Aðferðir: Íslenskir sjómenn, 77 að tölu, tóku þátt í rannsókninini frá desember 2012 til mars 2013. Af þessu þátttakendum höfðu 35 sjómenn tekið þátt í hreyfi- og næringaríhlutum sex árum áður með það að markmiði að bæta lífsstíl og lífsgæði. Hæð, þyngd, líkamsþyngdarstuðull (BMI), mittisummál, mat á líkamsfitu (BF%) og blóðþrýstingur (BP) var mælt. Blóðfitur og blóðsykur var mælt í blóði. Loftháð þol var mælt með hámarks áreynsluprófi á hjóli. Upplýsingum um reykingar, hreyfingu, sykursýki og notkun blóðþrýstings- og blóðfitu lyfja var safnað með spurningalistum. Heilsutengdar mælingar voru bornar saman milli mismunandi hópa með ANCOVA dreifigreiningu og með t-prófi innan undirhópa.

Niðurstöður: Hærri gildi voru mæld meðal íslenskra sjómanna á árinu 2013 samanborið við mælingar fyrir sex árum í hlébilsþrýstingi, lágþéttni lípópróteini (LDL), heildar kólesteróli og fastandi blóðsykri. Þol lækkaði um 7% (p=0,015) á sama tíma. Hjá íhlutunarhópnum hafði þyngd hækkað um 3% (p=0,05) og líkamsþyngdarstuðull einnig um 3% (p=0,047) á sama sex ára tímabili. Loftháð þol hafði lækkað um 11% (p=0,0002) hjá íhlutunarhópnum á sama tímabili. Árið 2013 var hreyfing hlutfallslega algengari (42% á móti 30%, p=0,435) og reykingar hlutfallslega sjaldgæfari (17% á móti 26%, p=0,400) hjá íhlutunarhópnum miðað við aðra sjómenn. Sama ár var minna um offitu hjá íhlutunarhópnum miðað við aðra sjómenn (17% á móti 32%, p=0,046).

Ályktun: Gögn rannsóknarinnar gefa til kynna að heilsa íslenskra sjómanna hafi verið verri árið 2013 samanborið við fyrri mælingu sex árum áður. Heilsa sjómannana sem tóku þátt í hreyfingar- og næringaríhlutun árið 2007 hafði versnað og voru þeir að hluta til í sömu stöðu eða verri sex árum seinna, en þó að sumu leyti betur á sig komnir en þeir sem ekki höfðu fengið neina íhlutun.

Abstract

Health of Icelandic fishermen - 2012

Objectives: To explore the changes in a number of health-related factors of Icelandic fishermen over a period of six years. Furthermore to investigate the long-time effects of a previous lifestyle intervention on physical activity adherence, and various health-related variables.

Methods: Icelandic Fishermen (n=77) participated in this study between December 2012 and March 2013, thereof 35 fishermen who participated in a previous study, that included an intervention for improved lifestyle, six years earlier. For comparison, baseline data from the intervention study was available for 62 fishermen. Height, weight, body mass index (BMI), waist circumference, estimates of body fat percentage (BF%) and blood pressure (BP) were measured. Blood lipids and blood glucose were measured. Aerobic fitness (W/kg) was measured with a maximal workload on a graded bicycle test and was then later converted into VO^2max. Smoking status, physical activity, diagnosed diabetes and blood lipid- and blood pressure medication use was obtained through questionnaires. Health related measurements were compared between different groups using ANCOVA or within-samples t-test when analysing the subgroup of the intervention study.

Results: Higher values in diastolic blood pressure, low-density lipoprotein total cholesterol and fasting glucose were measured among all fishermen in the year 2013 compared with six years earlier. Average aerobic fitness had decreased by 7% (p=.015) during the same time. Among the intervention group average weight and body mass index had increased by 3% (p=.05) and-3% (p=.047) respectively during a 6 year follow-up. Average aerobic fitness had decreased by 11% (p=.0002) in the intervention group. In 2013 self-reported physical activity was relatively higher (42% vs. 30%, p=.435), and smoking was relatively lower (17% vs. 26%, p=.400) in the intervention group compared to other fishermen. Also obesity was lower in the intervention group compared to other fishermen (17% vs. 32%, p=.046).

Conclusions: The health condition of fishermen declined over a six years period. The fishermen who had received physical activity and nutrition intervention had mostly returned to their previous state or declined six years later but had better health behaviour and lower prevalence of obesity compared with their younger counterparts.

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Abbreviations

BMI, Body Mass Index

BIA, Bioelectrical Impedance Analysis

DBP, Diastolic Blood Pressure

CHD, Coronary Heart Disease

COPD, Chronic Pulmonary Obstructive Disease

CVD, Cardiovascular Disease

FM, Fat Mass

FFM, Fat Free Mass

HDL, High Density Lipoprotein

IQL, Icelandic Quality of Life Questionnaire

LDL, Low Density Lipoprotein

METs, Metabolic Equivalents

MS, Multiple Sclerosis

QOL, Quality Of Life

SBP, Systolic Blood Pressure

SD, Standard Deviation

SKF, Skin Fold Thickness

TBW, Total Body Water

TC, Total Cholesterol

VO_2max, Maximal Oxygen Uptake

WHO, World Health Organization

%BF, Body Fat Percentage

1 Introduction

There is extensive evidence which demonstrate that physical activity is important in overall health. Using physical activity as a remedy to improve health and increase vitality has been utilized throughout human history as far back as 2500 B.C. in China. The Indian Ayurveda system of medicine from the ninth century B.C. was developed to improve health through physical exercise and the Greek physicians, Herodicus, Hippocrates, Asclepiades and Galen recommended physical exercise to improve health and well-being (Dishman et al. 2004).

Still today it is common knowledge that an inactive lifestyle is connected to mortality (WHO, 2002 and WHO, 2003) and according to the World Health Organisation (2009) Global Health Risks Report an inactive lifestyle accounts for as much as 6 % of all mortality in the world. It is of interest that according to the report factors that can be improved by increased physical activity and an active lifestyle, account for a substantial percentage of mortality in the world. These factors are high blood pressure, high blood glucose and overweight and obesity, accounting for 13%, 6% and 5% of worldwide mortality respectively. Also according to the report (WHO, 2009) the top four risk factors that might increase mortality are widely different in each income group. Childhood underweight, high blood pressure, unsafe sex and unsafe water, sanitation and hygiene are the leading risk factors for the low income group. On the other hand the leading risks for the high income group are tobacco use, high blood pressure, overweight and obesity and physical inactivity, (WHO, 2009). The high income group's leading risk factors are all lifestyle related. The prevalence of lifestyle related risk factors have increased in the westernized countries for the past 20 years, as economic development, industrialization, economic- and urban development and marked globalization have become more prominent.

Iceland is no exception when it comes to increased prevalence of lifestyle related diseases that can decrease health, quality of life and be the direct or indirect cause of death. Per capita supply of food in Iceland had been increasing up until 2002 (Þorgeirsdóttir, 2002) but seems to have stagnated at the onset of the financial crisis in 2008 (Þorgeirsdóttir et al. 2012), also 33% of the population recorded no leisure time physical activity in 2002 (Statistics Iceland, 2004a). This has led to an increased prevalence of overweight (BMI 25,0-29,9 kg/m^2) and obese (BMI >30,0 kg/$m^{2,}$ Cole et al. 2000) individuals in Iceland (Valdimarsdóttir et al. 2009). In 1990, 36% of the Icelandic population were overweight and 8% were obese. In 2002 the prevalence of overweight and obesity had soared to 48% and 12% respectively (Statistics Iceland, 2004b). In 2010 obesity had increased to 21% in Iceland (OECD, 2012, Þorgeirsdóttir et al. 2012).

The prevalence of overweight and obesity related causes of deaths in Iceland are increasing. In Iceland the main reasons for death in 2009 were cardiovascular diseases (CVD), ischemic heart diseases came second, cerebrovascular diseases were third and cancers were the fourth leading cause of death (Statistics Iceland, 2010). Cardiovascular diseases are the main cause of death in the developed countries, accounting for as much as 50% of all-cause mortality in these countries (WHO, 2002). Also cardiovascular diseases are the third leading cause of death in developing countries, and are thought to cause around 20% of all deaths each year worldwide (Dishman et al. 2004). In Iceland death caused by cardiovascular diseases, ischemic heart diseases or cerebrovascular diseases was lower in 2009 than in 1990 (Statistics Iceland, 2010), decreasing by 2,4%, 19,9% and 11,1% respectively. Death caused by malignant cancers of the colon, rectum and anus, and prostrate have increased during the same period by 56,2%, 18,1% and 29,2% respectively. The numbers of deaths caused by diabetes mellitus have also increased with the increased rates of overweight and obesity in Iceland (Statistics Iceland, 2010).

Overweight and obesity increases the likelihood of an individual being diagnosed with cardiovascular disease and certain cancers, such as breast-, colon-, rectal-, and prostate cancer (Bouchard et al. 2007, Dishman et al. 2004). Also an increased prevalence of diabetes, apnea, musculoskeletal pain, dysphoria, hypertension and impaired fertility has been linked with overweight and obesity (Bouchard et al. 2007, Dishman et al. 2004). The higher incidence of lifestyle related diseases among overweight and obese individuals is associated with low physical activity (Dishman et al. 2004).

The American Heart Association (Fletcher et al. 1996), the World Health Organization (2002) and the International Society and Federation of Cardiology (Bijnen et al. 1994) have recognized physical inactivity as an independent risk factor for coronary heart disease (CHD), and physical inactive individuals are believed to be at twice the risk of being diagnosed with CHD than a physically active individual. Also an inactive individual is up to four times likelier to be diagnosed with colon cancer compared with individuals who are more active (Arraiz, Wigle and Mao, 1992). Also Thune and Furberg (2001) concluded that physical activity, be it leisure time or occupational, can significantly reduce the rate of prostate cancer by 10% to 70%. Friedenreich and Orenstein (2002) concluded that physical activity is associated with an average of 10% to 30% reduction in breast cancer risk.

Physical activity is a very important factor when determining health. Throughout time various individuals have been trying to define health. The WHO presented a much used definition in 1948:

> "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity"

Physical activity on the other hand was defined by Caspersen et al. (1985) as:

> "Any force exerted by skeletal muscle that results in expenditure above resting level"

It has been concluded that endurance and cardiorespiratory fitness is the strongest factor in determining the health of an individual (Diaz et.al. 2006, Gerson and Braun, 2006, Ortega et al, 2013), and it has been shown that individuals who are overweight or obese with good endurance and cardiovascular fitness are in no more danger of being prognosed with CHD than an individual who is of normal weight or body fat percentage (Diaz et al. 2006 and Ortega. et al. 2013). So clearly the fitness of the individual is paramount.

1.1 The work of fishermen

Being a fisherman in Iceland has long been regarded by the general population as a harsh and difficult occupation. It can thus be expected that there is a selection bias as to who becomes a fisherman; this is referred to as the healthy worker effect. The healthy worker effect is a term used to explain individuals who become selected into an occupation that is unusually harsh or dangerous compared to other occupations. There are different aspects to the selection process of the individuals (Last, 1995, Checkoway et al, 2004):

1. The individual will self-select to apply for the dangerous occupation; he will think himself healthy enough.
2. The employer will select between those who apply, selecting the healthiest, and he will maintain in employment the healthy.

3. The selected individuals who become unhealthy will quit their work and leave the healthier workers in the employment pool.

The result is that the workforce at the workplace might not be a true cross section of the general population because they are selected into the occupation and will have better health.

The work and work environment of fishermen will tax all aspects of the definition of health made by the WHO (1948); the physical, mental and social well-being. The working environments on ships are often full of stressors that might have an effect on the well-being of the fishermen. These might be the feeling of overhanging dangers, being away from loved ones, difficulties in social cooperation, shift work and disrupted sleep patterns, working with heavy machinery and the dangerous and confined work environment on board a ship (Ólafsdóttir, 2004, Costa, 2003, and Matheson et al., 2000).

Being a fisherman is not only strenuous work, due to the physical elements of the work that test both strength and endurance, but also due to psychological factors. These factors are caused by the constant chance of injury and sickness, as well as the risk of drowning. (Rafnsson et al., 1992 and Jaremin et al., 1997).

Fishermen are often cramped into small cabins and bunks in close proximity with other members of the crew. This means that the fishermen's ability to cooperate and express themselves with others gets strained and tested every day. There is pressure to resolve differences quickly, as not to affect the moral of the crew; this affects social and psychological well-being. It is difficult for the fishermen to withdraw from any differences or conflicts they might have with each other, as space is limited and this further increases stress and decreases well-being (Ólafsdóttir, 2004).

Fishermen on bigger fishing vessels most often work in shifts and will have to work interchangeably at day and night which leads to an interference in the cooperation of the endogenous circadian timing system and the environmental synchronizers, which will disturb the normal psycho-physiological functions such as the night and day, sleep and wake rhythm (Folkard et al., 1985, and Minors and Waterhouse, 1986). Environmental objects such as lighting and engine- and machinery noise might also impair sleep and rest. This continuous strain on the body to adjust to these day/night rhythms changes, can lead to increased fatigue, insomnia, drowsiness, digestive troubles, disorientation, irritability, poor mental ability and reduced performance efficiency (Costa, 2003 and Ólafsdóttir, 2004), they suffer from "jet-lag" or, as Costa (2003) calls it, "shift-lag". As much as 20% of Icelandic fishermen suffer from insomnia and 46% suffer from chronic fatigue (Ólafsdóttir, 2004). Suffering from deprived sleep and insomnia can be factors that contribute to human errors in shift work occupations that lead to accidents and injuries because of fluctuating degrees of mental awareness and focus (Monk et al., 1996). They only have a limited amount of time to nourish themselves and sleep before their shift begins again.

Another disadvantage of shift work is the negative effects on social well-being. Being away from family and friends for long periods of time not only diminishes the time spent with these, but it also diminishes the quality of that time and leads to social isolation (Jaffe et al, 1996, Escriba-Aguir, 1992). It is difficult to maintain strong and meaningful friendships when one is out at sea for days, weeks and even months at a time. Communications among family members also becomes strained as the shift worker is not able to maintain his role inside the family. As a result, the typical male fisherman will become less of a father figure or a husband to his children and wife (Jaffe et al, 1996, Escriba-Aguir, 1992). Also Individuals in shift-work are more likely to be inactive and shun physical activity and interests because of the feeling of futility.

Fishermen have to have a good balance if they are to successfully work on board a ship. The movement of the ship means that they will continuously have to use the muscles that keep the body erect to hold their balance and roll with the ship. These muscles, such as the leg, hip and lower back muscles, as well as the hip, knee and ankle joints will be under much strain for a considerable amount of time. This leads to a significant amount of musculoskeletal injuries (Icelandic Social Insurance Administration, 2008b) and an increased health insurance cost. The work of fishermen is often repetitive and can therefore cause Repetitive Strain Injury (Ólafsdóttir, 2004) and damage to muscles, tendons and bones due to continuous repetitions and strain. Many individuals also tend to have poor posture characterized by a bent back and slumped shoulders. It has been shown that the endurance of individuals with a poor posture is often low. A poor posture can lead to chronic pain in muscles, tendons and joints, especially in the neck-, shoulder- and back regions (Pascarelli, 1994) which can increase sick leave from work (Kaaria et al. 2012). These problems are not uncommon in today's society as workers are under high pressure of working efficiently and fast.

It has been shown that Icelandic individuals working in the labouring industry, carpenters, mechanists, fishermen etc. tend to report lower health, more physical discomfort and more musculoskeletal injuries than individuals from a higher class (Vilhjálmsson, 2000). It has also been shown that individuals who spend less time in school tend to be more prone to CVD and have a higher mortality rate than others (Harðarson et al., 2001 and Guðmundsson et al. 1998).

The accident rate for Icelandic fishermen is high but has been decreasing for the past decades as safety on-board ships is better and the fishermen are better educated in safety matters. In 1991, 522 accidents were recorded to the State Social Institute of Iceland, in 2001, 344 accidents were recorded and in 2011, 252 accidents were recorded (Statistics Iceland, 2012). Accidents that were fatal were 10 in 1991, 2 in 2001 and 1 in 2011. According to the State Social Security there were 291 reported accidents involving fishermen in 2008 (Icelandic social Insurance Administration, 2008a) and the cost of the insurance payment of the fishermen was substantial as in 2008 there was a total of 2.160 reported accidents in al occupations in Iceland. The accidents among fishermen will have accounted for 13.4% of the reported accidents to the State Social Security Institute in 2008, and as in 2008 a total of 603.3 million Icelandic Kronas were used in insurance payments due to occupational accidents (Icelandic Social Insurance Administration, 2008b), 80.8 million Icelandic Kronas were the cost of the insurance payments for fishermen that year. Also the insurance cost of Icelandic fishermen who get injured at work accounted for 17% of the total insurance payments in Iceland in 2008.

A question is whether some of these injuries could have been avoided if the fitness and health of the fishermen had been better, as it has been proven that low levels of fitness is an independent risk factor for musculoskeletal injuries (Heir and Eide, 1997).

There are not many studies of the health and wellbeing of fishermen in Iceland but the ones that have been done have given a good perspective on this working class. In 1975 Helgason et al. were the first to study the health of Icelandic fishermen. Here it was concluded that physical- social- and psychological health of Icelandic fishermen was lacking.

Ólafsdóttir (2004) did a study on the effects that sleep and rest has on health, well-being and safety of Icelandic fishermen by monitoring their sleep patterns with an activity monitor, the quality of sleep with a questionnaire and their quality of life by using the Icelandic Quality of Life questionnaire (IQL) which has been made appropriate for use in research in Iceland by Helgason et al. (1997). To measure the fishermen's health she measured blood pressure, BMI, %BF, blood sugar, physical exercise and endurance. Their quality of sleep and sleeping patterns were not good. They had trouble falling asleep and 19% reported waking up during sleep because of pain and 20% were suffering from insomnia. The fishermen reported numeral factors having a negative effect on sleep and rest, such as noise, pain and bad sleeping accommodations. Furthermore 55% of the fishermen were not fully rested after sleep and 52% reported being sleepy during their shifts.

The fishermen had a low score in overall quality of life. 44% of the fishermen had elevated to high blood pressure, 27% had high blood lipids, 24% of the fishermen were overweight, 22% were obese and 8% of the fishermen were morbidly obese. The endurance of the fishermen was below average and 84% of the fishermen reported no or less than two times/week of physical exercise.

Olafsdottir et al. (2012) examined the health and fitness of 62 Icelandic male fishermen working for the fishing corporation Brim Ltd. Measurements included blood- and fitness tests and questionnaires to estimate physical activity and quality of life. Altogether 53% of the fishermen were overweight, 13% of them were obese, and 3% were morbidly obese. Of the fishermen 56% had below average fitness. Their quality of life, measured with the questionnaire by Helgason et al. (1997) was below average for the average Icelandic male.

Of interest is that the 62 fishermen were divided into two groups; an intervention group (n=31), which went through a 6 months physical activity and nutrition intervention, and a control group (n=31) which received no intervention. The intervention group increased their health as they improved their health related measurements. The control group had no significant changes in either variable. It was concluded that an intervention at sea can improve health and quality of life in Icelandic fishermen (Olafsdottir et al., 2012). Olafsdottir et al. were the first to study the health of Icelandic fishermen and at the same time study the effects of a physical activity and nutrition intervention on health and quality of life.

2 Theoretical background

In this chapter some of the health related factors and the implementations these might have on the health, well-being and quality of life of adults, and more specifically those of fishermen will be explained. Also, this chapter will explain why these factors are important in risk classification.

2.1 Anthropometric measurements

Anthropometric measures refer to the measurements of the size and the proportions of the human body (Heyward and Wagner, 2004). Measures of body size are weight and standing height. Ratios such as weight to height, known as the Body Mass Index BMI, present us with proportions. Special segments of the body can also be measured by circumferences and Skinfold Thickness (SKF) which will be presented later in this chapter.

Basic body composition assessment can be expressed with a two-compartment model as the relative percentage of the body mass that is fat and fat-free tissue, which is everything else than fat (Thompson et al. 2010). There are more complex compartment models involving up to six compartments but it is beyond this thesis to further explain compartment models involving more than two compartments.

There are various techniques to estimate body composition. These include the expensive laboratory and less expensive field techniques. Laboratory techniques are more accurate although more costly and complex. Field techniques are less accurate, less expensive and often less complex. The gold technique of body composition is a laboratory technique called hydrodensitometry or hydrostatic weighting, which includes lowering the individual into water and attaining the individual's body volume (BV) from the water displaced by the submerged body. There are other laboratory techniques but I will not further explain them here. Body composition field techniques involve SKF, which is a measurement of the thickness of subcutaneous adipose tissue by using a skinfold calibre on up to 9 sites on the body; circumferences involve measuring the circumference of various body parts where subcutaneous adipose tissue is usually located, and Bioelectrical Impedance Analysis (BIA) method involves passing a low-level electrical current through the individuals body to measure the total body water (TBW, Heyward and Wagner, 2004). There are other field techniques but as they are not important to this thesis I will not go into them. All techniques have assumptions and therefore measuring errors but they have been acknowledged as usable in research.

In this chapter the following body composition techniques and measurements that can predict disease risk will be further explained: BMI, waist circumferences and body fat percentage calculated from BIA measurements.

2.1.1 The Body Mass Index (BMI)

The prevalence of overweight and obesity has increased globally (Cavill et al., 2006, WHO, 2002, 2003, 2009 and Cole et al. 2000) and Iceland is no exception from this (Þorgerisdóttir et al., 2001, Statistics Iceland, 2004, Valdimarsdóttir at al. 2009). The easiest and most widely used measurement of overweight and obesity in a population is the BMI. BMI is used to assess weight relative to height and is calculated by dividing bodyweight in kilograms with the height in meters squared ($kg \cdot m^{-2}$). For most people a BMI of ≥25 $kg \cdot m^{-2}$ indicates overweight or obesity related health problems and an increased disease risk (Expert Panel on the Identification, Evaluation and Treatment of Overweight and Obesity in Adults, 1998 and Adams et al., 2006). An increased BMI has been shown to increase the likelihood of morbidity even without other risk factors (Adams et al. 2006). Interestingly it has been shown that the influence of obesity on mortality may have decreased between the years 1971 and 2000 probably because of improved public health and medical care (Flegal et al. 2005). The different classes and the risk of disease of each class of the BMI can be seen in table 1.

Table 1. The classes of the Body Mass Index (BMI) and related disease risk

Class	BMI ($kg \cdot m^{-2}$)	Disease risk[a]
Underweight	<18,5	Increased
Normal weight	18,5-24,9	No increased risk
Overweight	25,0-29,9	Increased
Obesity class I	30,0-34,9	High
Obesity class II	35,0-39,9	Very high
Obesity class III	≥40,0	Extremely high

[a]Disease risk is for type 2 diabetes, hypertension and CVD. Modified from Expert Panel on the Identification, Evaluation and Treatment of Overweight and Obesity in Adults, 1998 and Cole et al. 2000.

In Iceland the mean BMI of men was 24.8 $kg \cdot m^{-2}$ in 1980, and had increased to 27.2 $kg \cdot m^{-2}$ in 2008 (Nichols et al. 2012) showing the increasing rate of overweight among Icelandic men.

BMI is a practical mean of measurement but is not without flaws. BMI fails to distinguish between body fat, bone mass and muscle mass. Therefore an individual with a low percent body fat and increased muscle mass, such as an athlete, might be classified by the BMI as overweight, or even obese, even if he is not. Also elderly people might be misclassified as of a healthy normal weight when in fact their body fatness is increased and their bone and muscle mass decreased, because of age associated muscle dystrophy and increased adiposity (Horani and Mooradian, 2002, Cetin and Nasr, 2014). So their body weight is the same as when they were younger but their health suffers because their body composition is different. An increase in BMI has been linked to an increased prevalence of CVD and its risk factors such as angina pectoris, myocardial infarction, coronary heart disease and stroke (Wilson et al. 2002, Field et al. 2001 and Jonsson et al. 2002). Also an increased prevalence of diabetes, gallstones, hypertension, colon cancer (Field et al. 2001), and knee osteoarthritis (Willis et al. 2011) has been reported with an increased BMI.

2.1.2 Waist circumferences

It has been established that it is of great importance how excess body fat is distributed on the body. If located centrally around the abdomen it has been associated with the health risks of obesity (Itallie, 1988, Folsom et al., 1993, and Blair and Brodney, 1999), such as type 2 diabetes, hypertension, coronary artery disease, CHD and hyperlipidemia which are all factors contributing to the metabolic syndrome (National Institutes of Health, 1985 and Folsom et al., 1993). Adipose tissue located around and inside the viscera, also known as intra-abdominal fat, has been proven to be more dangerous than adipose tissue located at the gluteral-femoral region (Pi-Sunyer, 1991 and Folsom et al., 1993). Men are prone to deposit a larger amount of their excess body fat in the abdominal region than women, causing their abdomen to enlarge and become round in shape. For this reason central or android-type obesity is called apple shaped obesity. The female body on the other hand tends to deposit excess body fat round the femoral and gluteral regions, enlarging that area, this is called a pear shaped or gynoid-type obesity (Bjortorp, 1991).

Waist circumference measurements can be used to predict the body composition of an individual, and has a prediction error that is within 2.5%

to 4% of the actual composition of the body if the subject has similar characteristics as that of the original validation population for the body composition equation, and if done by a professional (Thompson, et al., 2010). Waist circumference measurements alone can be used to predict disease risk. The Expert Panel on the Identification, Evaluation and Treatment of Obesity in Adults (1998) classifies individuals with a waist circumference of >102 cm as in increased risk of type 2 diabetes, hypertension and cardiovascular disease. Furthermore Bray (2004) has provided a newer risk stratification scheme which can be seen in table 2. According to Bray's (2004) risk stratification the previous cut off values in waist circumference of >102 cm provided by the Expert Panel (1998), are too high. These values are however still widely used.

Table 2. Waist circumference and disease risk in men and women

	Waist circumference in cm	
Risk category	**Women**	**Men**
Very low	<70	<80
Low	70-89	80-99
High	90-109	100-120
Very high	>110	>120

From Bray, G. A. (2004).

Increased waist circumference increases the risk of the following diseases (McArdle et al., 2010):

- Hyperinsulinema
- Glucose intolerance
- Diabetes Mellitus, type II
- Endometrial cancer
- Hypertriglyceridemia
- Hypercholesterolemia
- Hypertension
- Atherosclerosis

The Expert Panel on the Identification, Evaluation and Treatment of Overweight and Obesity in Adults (1998) recommends using waist circumferences in combination with BMI to stratify overweight and obesity disease risk. Table 3 shows the combined use of waist circumference and BMI for assessing health risk.

Table 3. Combined use of waist circumference and BMI for assessing disease risk

Waist circumference	BMI category		
	Normal 18,5–24,9 kg·m^{-2}	Overweight 25–29,9 kg·m^{-2}	Obese class I 30–34,9 kg·m^{-2}
Men <102 cm Women <88 cm	Least risk	Increased risk	High risk
Men >102 cm Women >88 cm	Increased risk	High risk	Very high risk

From Douketis et al. (2005).

Using circumferences include the assumptions that circumferences are affected by fat mass (FM), muscle mass and skeletal size and that some circumferences are affected more by FM and less by muscle and skeletal size than others (Jackson and Pollock, 1978). The circumferences that are recommended to measure are waist, hips, upper thigh, fore- and upper arm and calf (Jackson and Pollock, 1978, Heyward and Wagner, 2004 and Thompson et al., 2010). Although it is possible to only use waist circumference to evaluate disease risk as abdominal obesity is the strongest indicator of disease risk (Thompson et al., 2010).

2.1.3 Body fat percentage (%BF)

As of yet a consensus opinion on an exact %BF value associated with optimal health has not been defined. Lohman (1982) has proposed a range of 10% to 22% for men and 20% to 32% for women as satisfactory for good health. Individuals exceeding these values would be defined as obese and could be in danger of suffering obesity related health problems (Philips et al. 2013).

Individuals with a high %BF are not necessarily in a worse situation, health wise, than a lean individual. Studies have shown that fit obese individuals, called “fat but fit”, are healthier and have a lower all-cause mortality and morbidity than their leaner, unfit counterparts (Lee et al., 1999 and Church et al. 2004) and their obese and unfit counterparts (Ekelund et al. 1988, Lee et al. 1999, Paffenbarger et al. 1986, Wei et al. 1999). Also, it seems that when assessing obese individuals one should remember that if their fitness is high, hen being obese is a benign condition

(Ortega et al., 2013). Obesity is however a strong predictor of cardiovascular disease risk and is considered a stronger predictor than aerobic fitness (Christou et al., 2005).

Body fat percentage in research studies are often obtained by using BIA. Basic BIA principles were proposed in the early 1960s by Thomasett (1962) which method involved passing a low level electrical current through an individual's body and the impedance, or the opposition to the flow of the electrical current, is measured with a BIA analyser. The BIA analysis is easy to use as it does not require a high degree of technician skill, it is generally comfortable, does not intrude on the individual's privacy, and it can be used on obese individuals (Heyward and Wagner, 2004, Gray et al., 1989, Segal et al., 1988).

The principles of the BIA are as follows: Biological tissues act as conductors or insulators and the flow of the electrical current will follow the fastest and easiest path through the tissues, which is the path of the least resistance. Fat free mass (FFM) in mammals is made up of around 73% water and electrolytes (Wang et al., 1999), which makes it a good conductor of electrical currents. Fat on the other hand constitutes of little water, around 20% for an adult individual (Baker, 1969), it is anhydrous and a poor conductor of electrical currents. The BIA measures TBW and FFM and uses equations to calculate body composition for different ethnic groups. The BIA has assumptions much like any other body composition techniques. It simplifies the body, assuming that it is a perfect cylinder with a uniform length and cross sectional area, instead of acknowledging that it is a complex geometric shape and varies in length, composition and cross sectional area (Van Loan, 1990). It also assumes that the body has a fixed frequency of 50 kHz, which is does not. The BIA method has prediction errors of 3.5% to 6% for FFM and 3% to 8% for TBW (Sun et al., 2003 and Kushner et al., 1992).

Using %BF in combination with BMI is a good indicator for disease risk as the two measurements are correlated (Gallagher et al., 2000) and can predict one another very well.

2.2 Hematologic values

In this chapter common procedures for examining the blood- and metabolic health profile of individuals will be accounted for. An explanation of the effect of the diverse compartments of the blood- and metabolic profile on health will also be explained.

2.2.1 Blood lipids

Blood lipids are important in body homeostasis. Lipids include triglycerides, phospholipids and cholesterol. Lipids not only provides fuel for energy but are also used by the cells for various purposes and functions such as absorption of fat-soluble vitamins, cell membrane structure and hormone synthesis. Excess lipids ingested are stored as adipose tissue on the body for future use.

The amount of lipids in the blood is highly dependent on the individual and is not always reflected by the amount of adipose tissue (Wilmore et al., 2004). Blood lipids have been the focus of attention in the medical community because of its role in atherosclerosis, a thickening of the arterial wall which narrows the lumen of the artery and decreases blood flow (Powers and Howley, 2012). Blood lipids can be divided into various types. I will focus on cholesterol and the two subtypes that cholesterol is mostly divided into, although there are more types than just two (Krauss et al., 2000), namely HDL and LDL. The lipoproteins are vessels that carry cholesterol around to their designated destinations and are therefore important in homeostasis regulation (Daniels et al. 2009). LDL transfers cholesterol to the cells in peripheral tissues and HDL transfers cholesterol from peripheral tissues to the liver. Cholesterol is mostly made by the liver although some of it comes directly from diet (Bean, 2010).

Recommended values of lipids in the blood can be seen in table 4. LDL cholesterol is the largest constituent of blood cholesterol and is mostly affected by dietary fats, most notably saturated fats (Kraus et al., 2000 and Bean, 2010) whereas HDL cholesterol is largely affected by heredity, gender and physical exercise (Powers and Howley, 2012).

In Icelandic men aged ≥25 years the prevalence of total blood cholesterol of ≥6.2 mmol/L was 30.2% in 2008 (Nichols et al. 2012). The mean blood cholesterol levels have been declining from 6.1 mmol/L in 1980 to 5.7 mmol/L in 2008.

Table 4. Blood classifications of LDL-, HDL-, total cholesterol and triglycerides (mmol/L)

LDL Cholesterol	
< 3.0	Desirable
3.0 – 4.0	Borderline high
4.1 – 4.8	High
≥ 4.9	Very high
HDL Cholesterol	
< 1.0	Low
≥ 1.5	High
Total cholesterol	
< 5.2	Desirable
5.2 – 6.2	Borderline high
≥ 6.3	High
Triglycerides	
< 1.6	Normal
1.6 - 2.2	Borderline high
2.3 – 5.6	High
≥ 5.6	Very High

Modified from National Cholesterol Education Program (2002)

Total cholesterol is an independent risk factor of cardiovascular disease in Iceland, and according to Þorgeirsson et al. (2005) an increase in 1 mg/dl of total cholesterol will increase the risk of cardiovascular disease with 1,1% for Icelandic men. High amounts of LDL in the blood is directly related to cardiovascular disease risk and lowering the amount of plasma LDL is associated with extensive reduction in CVD incidences (Thompson et al., 2010). High amounts of plasma HDL appear to protect against cardiovascular diseases (Chait et al., 1993) but it has not proven to be an independent marker of protection from atherosclerosis and other cardiovascular diseases (Krauss et al., 2000). The reason for this is that higher levels of HDL in blood are inversely related to the risk of disease which may be lower because of other factors. As plasma HDL cholesterol is increased by physical exercise (Lehman et al., 2001, Durstine et al., 2002 and Gupta and Rajagopal, 2007), individuals who exercise regularly tend to eat healthier, LDL cholesterol levels will often be lower at the same time decreasing the risk of disease. HDL cholesterol in combination with other factors thus seems to protect against disease.

High plasma levels of Triglycerides contribute to an increased risk of coronary disease although it is not known whether the level of triglycerides itself or their interrelation with low levels of HDL, high levels of LDL, insulin resistance and coagulation factors is the reason to an increased disease risk (Þorgeirsson et al., 2005 and Krauss et al., 2000). High levels of plasma triglycerides have as of yet not classified as an independent risk factor of coronary disease but they are certainly relevant when examining the risk of disease as the interrelationship between relevant factors constitute the risk.

Epidemiologic studies have shown that the male sex is an independent risk factor of cardiovascular disease when using HDL levels to assess disease risk (Farnier et al., 2006, Ascherio et al., 1996, þorgerisson et al. 1992) as males tend to have lower HDL levels than women. Also HDL levels tend to be lower in individuals who suffer from diabetes mellitus type 2, abdominal obesity and hypertriglyceridaemia (Farnier et al., 2006). So clearly it is good to have a high level of HDL and a lower level of LDL in the blood so as to lower the risk of health degenerating diseases.

2.2.2 Blood glucose

The importance of blood glucose in the classification of health degenerating disease risk has long been established. Glucose is the main energy source of the body and therefore vitally important. The regulation of plasma glucose is a complicated phenomenon involving the hormones glucagon and insulin. Insulin is produced by the pancreas when the glucose concentration in the blood is high, promoting its transportation into the cells. Glucagon secretion is enabled when the glucose concentration of the blood is low, increasing breakdown of glycogen in the cells and increasing blood glucose (Bouchard et al., 2007 and Jennett, 2008).

If insulin is lacking or not present, the result is hyperglycaemia, high blood glucose (Jennett, 2008). Hyperglycaemia along with glucosuria, which is increased levels of glucose in urine, and decreased utilization of carbohydrate as fuel and more reliance of fat and proteins as fuels are known as diabetes (Jennett, 2008). Diabetes is a state where either the secretion of insulin is hindered or not present, or the cells have become less sensitive and responsive to the hormone.

Diabetes is divided into two types, Type I and Type II diabetes. Type I diabetes is an absolute deficiency of insulin (Hornsby and Albright, 2009).

Type I diabetes usually develops before age 30 but can occur at any age. Type I diabetes is thought to account for up to 10% all individuals with diabetes (Hornsby and Albright, 2009).

Type II diabetes is a state where peripheral tissues are resistant to insulin, and glucose is therefore not easily exported from the blood into the cells. It is thought that 90% of all diabetes patients have type II diabetes (Bouchard et al., 2007, Silbernagl and Lang, 2009, Hornsby and Albright, 2009). Most individuals who have type II diabetes are overweight or obese and all have a genetic disposition towards the disease (Silbernagl and Lang, 2009, Hornsby and Albright, 2009). Type II diabetes is associated with older age, obesity, physical inactivity, family history, gestational diabetes and ethnicity (Hornsby and Albright, 2009, Silbernagl and Lang, 2009).

Table 5 lists the classifications of fasting plasma glucose levels as stated by the American Diabetic Association (2004).

Table 5. Classification of fasting plasma glucose levels

<5,6 mmol/L	Normal
5,6 – 6,9 mmol/L	Impaired
≥7,0 mmol/L	High and pre-diabetic

Modified from the American Diabetic Association (2004).

Individuals who are diagnosed with diabetes are at risk of developing microvascular complications, because of the higher acidity of the blood, such as retinopathy, which is damage to the retina which can eventually lead to blindness after prolonged exposure to the disease (Klein et al., 1984), nephropathy, which is damage to the kidney; macrovascular diseases such as heart attack and stroke; and various other neuropathies (Hornsby and Albright, 2009).

In Iceland the prevalence of diabetes in men was 3% in 1967 but had increased to 6% in 2007, and it is thought that around 4% of the Icelandic population suffers from Diabetes (Þórsson et al. 2009). The increases in diabetes follow the global trend.

2.2.3 Blood pressure

Blood pressure is the pressure of the blood on the endothelial wall of the arteries when blood is propelled through them by the contraction of the heart (Wilmore et al., 2004, Jennett, 2008). There are two values for blood pressure; the upper limit or the systolic blood pressure and, the lower limit or the diastolic blood pressure. Systolic blood pressure (SBP) is when the heart is contracting and ejecting blood. Diastolic blood pressure (DBP) is the pressure when the heart is dilating and filling itself with blood. Table 6 depicts the classifications of blood pressure according to the seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (Chobanian et al., 2003). Elevated blood pressure changes the structure of the arteries and veins, resulting in a raised risk of a number of diseases such as stroke, heart disease, kidney failure and overall mortality (WHO, 2009 and Gordon, 2009). This is not only relevant for individuals who have hypertension, but also for individuals who have a small elevation in blood pressure (WHO, 2009).

Table 6. Classification of blood pressure (mmHg)

Category	SBP	DBP
Normal	<120	<80
Pre-hypertension	120-139	80-89
Hypertension stage 1	140-159	90-99
Hypertension stage 2	≥160	≥100

SBP, Systolic Blood Pressure; DBP, Diastolic Blood Pressure. From Chobaninan et al., 2003

The cause of elevations in blood pressure and hypertension are many. Most notably a diet with high salt and alcohol consumption, the lack of physical exercise, obesity and genetics are related to hypertension and high blood pressure (Bouchard et al., 2007 and WHO, 2009). Blood pressure also increases with age (Bouchard et al., 2007 and Burt et al, 1995).

Elevated blood pressure is a major public health problem in most industrialized countries and is related to the risk of CVD (Lewington et al., 2002 and Gordon, 2009). According to WHO (2002) around 11% of all disease burden can be traced back to hypertension and more than 50% of all CHD and almost 75% of stroke incidents in developed countries is due to increased systolic blood pressure. The relationship between hypertension and cardiovascular events is an independent risk factor and it is thought that an increase of 20 mmHg in SBP or 10 mmHg in DBP doubles the risk of CVD independent of whether the individual had high blood pressure or not (Thompson et al., 2010, Chobanian et al., 2003, Lewington et al., 2002 and Burt et al., 1995). Yusuf et al. (2004) estimate that 22% of heart attacks in Western Europe and 25% of heart attacks in Central and Eastern Europe are due to a history of hypertension. They also estimate that an individual with a history of hypertension is almost at twice the risk of suffering a heart attack compared to an individual without hypertensive history. Interestingly average blood pressure has been decreasing since 1980 in most countries, including Iceland, for both genders (Nichols et al., 2012) which is probably due to better healthcare. The prevalence of hypertension in Iceland is high as in the year 2008 40,2% of Icelandic men aged ≥25 years had hypertension or were on blood pressure controlling medication (Nichols et al., 2012).

Physical activity has been proven to be excellent in decreasing blood pressure (Gordon, 2009 and Chobanian, 2003). There is a consistent 10 to 20 mmHg reduction in SBP during the initial 1 to 3 hours after a 30 to 45 min session of moderate-intensity dynamic exercise in individuals with hypertension (Gordon, 2009). The change in blood pressure because of exercise has been proven to persist for up to 9 hours and does appear to be mediated because of a lower stroke volume, rather than an increased vasodilatation of the arteries in peripheral tissues (Gordon, 2009)

2.2.4 The metabolic syndrome

The metabolic syndrome was first mentioned in the late 1980's (McArdle et. al. 2010) and is a combination of CVD risk factors that confer a greater risk combined than each and every one factor alone (Thompson et al. 2010). Kahn et al. (2005) have questioned this statement, but it is generally agreed that the metabolic syndrome increases the risk of CVD. Therefore, the thresholds for each individual risk factor are lower than the usual thresholds. Grundy et al. (2005) have proposed new up to date criteria for diagnosis of the metabolic syndrome (table 7). According to Case et al. (2002) individuals diagnosed with the metabolic syndrome and diabetes mellitus are at thrice the risk of developing CVD compared with individuals who do not have the disorder. According to the Icelandic Heart Association (Hjartavernd, 2008) the prevalence of the metabolic syndrome in 50 to 60 year old Icelandic men was 20% in 2008.

Kahn et al. (2005) have proposed that the definition of the metabolic syndrome is incomplete and unclear. They propose that as there are different criteria for diagnosing the metabolic syndrome - the ones used by WHO (1999) and the Expert Panel on the Detection, Evaluation, and Treatment of High Blood Pressure (2001) being used the most, although they themselves are not the same - scientists and medical staff might misdiagnose.

Table 7. Criteria for diagnosis of the metabolic syndrome in men

Measurements	Thresholds
Elevated Waist circumference	≥ 102 cm
Elevated Serum Triglycerides	≥ 1.7 mmol/L or on medication for treatment of elevated triglycerides
Reduced HDL cholesterol	< 1.03 mmol/L or on medication for treatment of low HDL cholesterol
Elevated blood pressure	≥ 130 mmHg SBP or ≥ 85 mmHg DBP or on antihypertensive medication
Elevated fasting plasma glucose	≥ 5.54 mmol/L or on medication for the treatment of elevated plasma glucose

SBP= systolic blood pressure, DBP = diastolic blood pressure. Any three or more of the five criteria constitute the diagnosis of the metabolic syndrome.

Kahn et al. (2005) propose the following faults and concerns regarding the metabolic syndrome:

- The criteria are ambiguous and incomplete and the rationale for the thresholds are ill defined.
- Value of including diabetes in the definition is questionable.
- Insulin resistance as the unifying etiologic is uncertain.
- No clear basis for including/excluding other CVD risk factors.
- CVD risk value is variable and dependent on the specific risk factors present.

Also Kahn et al. (2005) and Franks and Olsson (2007), question the medical value of diagnosing the metabolic syndrome in individuals, and whether it should at all be defined as a distinct pathophysiologic condition or disease rather than a cluster of risk factors, as the treatment of the syndrome is no different than the treatment of the individual parts Treatment guidelines often include weight control, physical activity and in some cases pharmacotherapy for some of the associated CVD risk factors (National Cholesterol Education Program, 2002), but weight control and physical activity through a lifestyle change are by far the recommended treatments.

2.3 The importance of physical activity

Increased physical activity levels are related to increased health and well-being (Haskell et al. 2007, Olafsdottir et al. 2012, US Department of Health and Human Services, 1996, WHO, 2002, 2003, 2009, 2010). ACSM propose that for any individual aged 18-65 years to promote and maintain health he or she needs moderate-intensity aerobic physical activity for a minimum of 30 minutes at least five days a week or 20 minutes of vigorous-intensity physical activity 3 days a week, or a combination thereof (Haskell et al. 2007).

Moderate intensity equals a consumption of 3.0 to 6.0 metabolic equivalents (METs) such as walking at a very brisk pace, playing badminton, bicycling on a flat surface at 16 to 19 $km*h^{-1}$. Vigorous-intensity equals ≥6.1 METs and can be activities such as jogging or running, shovelling, carrying heavy loads, casual soccer or playing basketball (Ainsworth et al. 2000). One MET equals an individual's resting metabolic rate, the rate of energy usage when sitting still. Individuals can use the METs system to calculate their physical activity and energy expenditure (Ainsworth et al. 2007). It is recommended that adult individuals (35 years and older) expend at least 500 kcal per week, but preferably more if possible, as an invert relationship between physical activity and mortality exists with an expenditure of 500 to 3500 kcal per week (Paffenbarger et al. 1985). Interestingly at an expenditure of 3500 kcal per week the relative risk of CVD is less than half of that of the sedentary individuals (<500kcal per week) but does not further decrease at an expenditure over 3500 kcal per week. I will not explain the diverse methods scientists use to measure physical activity in a population except for the questionnaires that were used in this study (see chapter 3.1.4).

During the past 30 years, regular physical activity has gained acceptance as an important part of the prevention and rehabilitation of an expanding list of chronic diseases and disabling conditions (US Department of Health and Human Services, 1998), which in the long term can save considerable funds in healthcare. Table 8 lists some of the benefits of regular physical activity regarding its effect on health and quality of life

Table 8. Health benefits of regular physical activity

	Useful in the prevention of		
Stroke	**	High blood pressure	****
Prostate, uterine and breast cancer	**	CHD	****
		Weight gain	****
Colon cancer	****	Depression	****
Osteoporosis	***	Diabetes type II	****
Low back pain	**	Anxiety	****
	Useful in the treatment of		
Heart disease	***	Depression	****
High blood pressure	****	Anxiety	****
		Osteoporosis	**
	Improves		
Muscular strength	****	Sleep quality	***
Bone health	****	Mood	****
Plasma triglyceride levels	***	Life expectancy	****
Asthmatic's life quality	***	Plasma HDL levels	***
Diet quality	**	Health of fetus	**
Physical fitness	****	Health during menopause	***
Life quality	****		
Heart and lung function	****	Self-esteem	****

PA , Physical activity; CHD, coronary heart disease; **, some supportive data, more research is needed; ***, most data is supportive, more research needed for clarification; **** Strong consensus, little or no conflicting data. Based on McArdle et al. 2010.

Even though regular physical activity has either not been proven or needs more investigation to be further clarified as an impacting factor for improves health and quality of life of individuals with disease, it is still used in the rehabilitation progress of many diseases, many of whom are regarded as the leading causes of death worldwide (WHO, 2009). Even though physical activity might not prevent or treat a certain disease or disorder, it more often than not improves the quality of life and well-being of the patient (Steward et al. 1994). The most common diseases and disorders where regular physical activity can be used as a medium for improving fitness, quality of life and health are the following:

- Cardiovavascular diseases and disorders such as ischemia (Sacco et al. 1998); chronic heart failure (Hambrecht et al. 1998); Dislipidemia (McArdle et al. 2010); cardiomyopathies (Hambrecht et al. 1995); cardiac valvular disease (Friedman and Roberts, 2009); After a heart transplantation (Kavanagh et al. 1988) and congenital heart defect (Reybrouck and Mertens, 2005).
- Pulmonary diseases and disorders such as chronic obstructive pulmonary disease (COPD, Garcia-Aymerich et al. 2006); cystic fibrosis (Nixon, 2009) and asthma (Lucas and Platt-Mills, 2005).
- Neuromuscular diseases and disorders such as stroke (Gillum et al. 1996); multiple sclerosis (MS, Mostert and Kesselring, 2002); Parkinson's disease (Goede et al. 2001); Alzheimer's disease (Rimmer and Smith, 2009); polio (Willen and Grimby, 1998) and cerebral palsy (Rimmer, 2001).
- Metabolic diseases and disorders such as obesity (Lee et al., 1999 and Church et al. 2004); diabetes (Hornsby and Albright, 2009) and renal disease (Painter and Krasnoff, 2009).
- Immunologic and hematologic diseases and disorders such as cancer (Dishman et al., 2004) and HIV and AIDS (Hand et al. 2009).
- Orthopedic diseases and disorders such as osteoporosis (Smith and Wang, 2009); osteoarthritis (Vuori, 2001); rheumatoid arthritis (Hakkinen et al. 2001) and back pain (Simmonds and Derghazarian, 2009).
- Aging disorders such as sarcopenia (Roubenoff, 2007).
- Cognitive and emotional disorders such as anxiety and depression (Dunn et al. 2001) and Stress (Hand et al. 2009).

The type of physical exercise practiced to increase health and fitness does not seem to matter as both aerobic training exercise and strength training exercise decrease coronary disease risk (Banz et al. 2003), especially when used in combination (Najafipoor et al. 2012)

2.4 Fitness

To accurately measure the physical activity of a population is difficult. This problem is often resolved by measuring cardiorespiratory fitness, and to study the relationship between it, mortality and morbidity (LaMonte and Blair, 2007). Maximal oxygen uptake (VO_2max) has been accepted as the best way to measure cardiorespiratory fitness (Thompson et al. 2010, Katch et al. 2011). VO_2max is a product of the maximum cardiac output

(L*blood*min^{-1}) and arterial-venous oxygen difference (mL O_2 per L blood) and is measured as mL*kg*min^{-1} (Wilmore et al., 2004). The inclusion of weight into the measurement makes it possible to compare two individuals who vary in bodyweight. Significant variations in VO_2max across populations and fitness levels are mostly related to the cardiac output. Because of this VO_2max is closely related to the functional capacity of the heart and therefore morbidity and mortality (Thompson et al. 2010). Individuals with low cardiorespiratory fitness are more at risk of disease and premature death than their counterparts with normal or higher cardiorespiratory fitness (Blair et al. 1986, Blair et al. 1996, Church et al. 2004 and Barlow et al. 2012). Furthermore it is estimated than an individual who increases his or hers VO_2max with 3.5 mL*kg*min^{-1}, will reduce cardiovascular mortality risk by 18% and all-cause mortality risk by 11% (Barlow et al. 2012). Katch et al. (2011) have provided cardiovascular fitness classifications for different age groups of men based on VO_2max (mL*kg*min^{-1}) that can be seen in table 9.

Table 9. Cardiovascular fitness classification of men based on VO_2max (mL*kg*min^{-1})

Age	Poor	Fair	Average	Good	Excellent
≤29	≤24.9	25-33.9	34-43.9	44-52.9	≥53
30-39	≤22.9	23-30.9	31-41.9	42-49.9	≥50
40-49	≤19.9	20-26.9	27-38.9	39-44.9	≥45
50-59	≤17.9	18-24.9	25-37.9	38-42.9	≥43
60-69	≤15.9	16-22.9	23-35.9	36-40.9	≥41

From Katch et al. 2011

2.5 Quality of life

Measuring QOL has been called the third facet of health. Being equally important as physiological health, the WHO (1948) decided to include some of its subscales in the form of psychological- and social factors in its definition of health.

Quality of life is a multidimensional concept that includes all aspects of an individual's life. Health-related Quality of life (QOL) focuses only on the health-related aspects of the concept. Over the past 30 years the assessment of QOL has become an important segment of healthcare treatment for analyzing its effectiveness (Ferrans, 2005). QOL enables researchers to measure an individual's feeling towards a subject that cannot be measured by physiological- or biological measurements (Helgason et al, 2000). Therefore QOL has been called the third dimension of health-related measurements.

Health-related Quality of Life is a subjective means of rating personal health and well-being, or how an individual feels and functions in their everyday life (Kolotkin et al, 2001a). QOL is collected by questionnaires that have been standardized for a certain population. QOL consists of different facets that together give a good indication of individual physiological-, psychological- and social health and well-being (Helgason et al. 2000). These facets are; general health, depression, social functioning, financial status, energy, anxiety, physical health, self-control, general well-being, cognition and pain. QOL has been utilized in Iceland to improve the life quality of patients, especially patients with long-term sickness and life threatening diseases (Helgason et al. 2000), as it is not only desirable to increase the longevity but also the life quality of this population (Croog et al. 1986). QOL assessment is therefore not just another mean to assess treatment efficiency, but also to compare different populations.

A problem with QOL is its definition, as it is not explicit (Ferrans, 2005. This makes comparison between studies difficult as the definition is not the same. Another problem is that as QOL is measured with questionnaires that have been especially made to assess a certain population, who might have a certain set of problems, and might therefore inadequately measure factors that might be affected. Helgason et al. (2000) have designed a questionnaire that has been validated for use in Iceland. This questionnaire is further explained in chapter 3.1.5.1.

In Iceland overall QOL worsens with increased age (Helgason et al. 2000), and QOL is generally worse in women of all ages than in men of the same age, with sleep and physical health especially low.

Interestingly physical activity and fitness is an important factor in QOL. QOL is improved in individuals who meet the public health recommendations for physical activity (Vuillemin et al, 2005, Acree et al, 2006, Bize et al, 2007), and leisure-time physical activity at a higher intensity is associated with a greater QOL. Increased Physical activity is also linked to increases in QOL (Olafsdottir, 2012, Bond et al, 2006)

Also, heart disease, arthritis, diabetes and cancers have all been linked to low QOL in individuals suffering these diseases (Centres for Disease Control and Prevention, 2003). Also QOL of obese individuals is usually low, with the lowest rates associated with the greatest degrees of obesity (Kolotkin et al, 2001a). QOL improves with weight loss and improved physical activity in these populations (Dano, 1977, Kolotkin et al. 2001b), with a greater weight-loss associated with a greater increase in QOL.

2.6 Aims of this study

In Iceland it is publicly thought that fishermen are in good health and that they are strong and fit. This belief has been spurred on by stories of fishermen who somehow have found themselves in the cold waters off ship and have swum many miles to land and have miraculously survived. Studies have shown otherwise (Ólafsdóttir, 2004 and Olafsdottir et al. 2012) but none have studied the effects of a physical activity and nutrition intervention on the health and fitness of Icelandic fishermen in the long run.

It is of no question that if employees of a workspace have good health, fitness and wellbeing it will benefit not only themselves but also the employers and the society as a whole. These factors depend a great deal on the amount of physical activity of a person as physical activity improves health, as mentioned before. Therefore, it is important to study the long-term effects of an intervention study to see whether these can be used to improve health and wellbeing in society which will be of great benefit. This study is a follow-up study of the study made by Olafsdottir et al (2012).

There were four objectives to this thesis

- The first objective of the present study was to explore the changes in a number of health related factors of Icelandic fishermen during a period of six years.
- Using data on a subgroup of the study, our second objective was to investigate the effects of the previous lifestyle intervention study on physical activity adherence, and various health related factors at three time-points over a period of six years.
- The third objective was to study whether there was a difference in health related factors between the intervention group and a pooled control group six years later.
- The fourth objective was to explore the changes in quality of life of Icelandic fishermen during a period of six years, and whether there was a difference between the intervention group and a pooled control group during this time.

3 Materials and methods

3.1.1 Study design and population

This study is a retrospective cross-sectional study

Participants were fishermen working for the same fishing company on six different trawlers located around Iceland. Previously an intervention study was conducted in 2007 including sixty-two participants working for the same fishing company which has been described elsewhere (Olafsdottir et al, 2012). All crew members and former participants in the 2007 study (in total 136) were invited to participate in the current study, (figure 1).

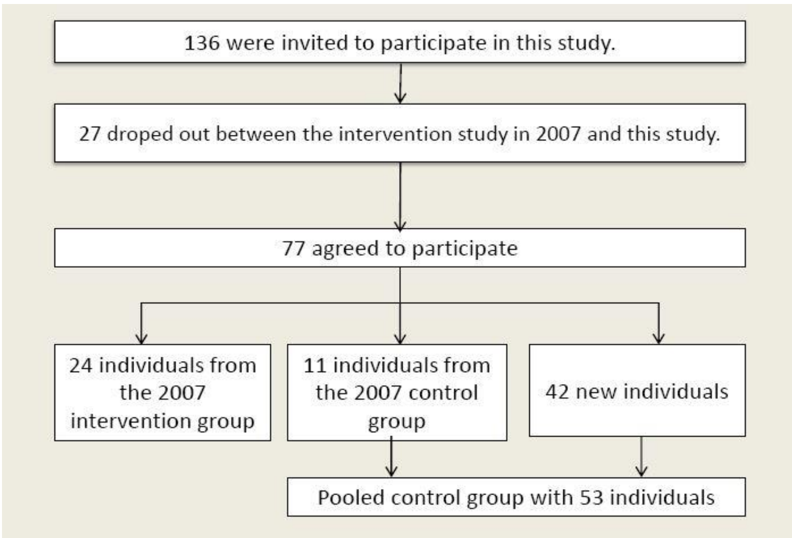

Figure 1. Flow-chard of participation

Between December 2012 and March 2013, seventy-seven (56.6% response rate) fishermen agreed to participate and gave their written informed consents. Thirty five individuals who participated in the intervention study in 2007 participated in the present study (56% response rate), thereof 24 men from the intervention group (all working on the same trawler, 77% response rate) and 11 men from the control group (working on the five other trawlers, 35% response rate). A total of 42 fishermen who had not previously participated agreed to participate.

The study protocol was approved by the Icelandic Ethical Review Board (VSNb2007030018/03.7).

3.1.2 Antrophometric measurements

3.1.2.1 BMI and Body fat percentage (%BF)

Weight, bodyfat percentage (%BF) and BMI were obtained using a Tanita TBF-310 body composition analyser (Tanita Corporation, Tokyo, Japan).

Before the measurement the participant were be informed to:

- Not drink alcohol within 48 hrs.
- Neither eat nor drink (especially foodstuff containing caffeine) within 8 hrs.
- Empty their bladder.
- Not to exercise vigorously within 12 hrs.
- If possible, not use diuretics 7 days prior to measurement.

Implementation:

- The participant wore nothing but underwear.
- They stood straight with both feet planted on the middle of the platform of the composition analyser with their hands by the sides.
- The heights of the participants were then inserted into the analyser.
- The results from the analyser gave the participants weight, BMI, %BF and composition of the body.
- Any individual who had a pacemaker were not measured on the Tanita body composition analyser.

3.1.2.2 Waist circumference

Waist circumference was measured according to the recommendations by WHO (2008) using a non-elastic measuring tape.

Implementation:

- Participant did not wear clothing that covered the upper part of the body.
- Both feet were planted solidly in the floor, shoulder-width apart with arms by the side.
- The abdomen was relaxed and breathing was normal.
- The measurement was performed at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest.
- The measuring tape was placed tight against the skin.

3.1.3 Hematologic measurements

3.1.3.1 Blood- lipids and glucose

Participants were asked to fast overnight (≥10 hours) so blood samples of serum total cholesterol (TC), high-density lipoprotein (HDL), triglycerides and glucose could be obtained. Low-density lipoprotein (LDL) was calculated using the Friedewald et al. (1972) equation. Blood samples were obtained following the procedure used by the Icelandic Heart Association.

Implementation:

- The participant lay on his back with his arm extended at a 90° angle out to the side.
- The area around a lower arm vein on the interior side was sterilized and prepared with a needle.
- The first blood was sampled into a low pressure blood test bottle; successive samples were then drawn into separate test bottles containing EDTA (Ethylene diamine tetraacetic acid) and sodium citrate respectively. Each glass was labelled with the participant's name, ID-number and study group.
- Blood samples were then analyzed using WinLIMS (Windows based laboratory information management software, Quality Systems International (QSI), New Jersey, USA).
- Blood sample results were stored in a secure database.
- Blood samples were stored in special storage containers and frozen.

3.1.3.2 Blood pressure

Blood pressure measurements were measured according to Pickering et al. (2005) using a sphygmomanometer (Baumanometer, Wall Unit 33, type 0850, W. A. Baum Co. Inc.).

Implementation:

- The participant was instructed to lie on his back with his feet straight for 5 minutes. Allowing the pulse to return to normal.
- The cuff was preceded by selection of the appropriate cuff size for the participants arm circumference.
- The midline of the bladder of the cuff was placed so that it covered the arterial pulsation of the brachial artery on the right arm.
- The lower end of the cuff was 2-3 cm. above the antecubital fossa.
- The stethoscope was placed over the brachial artery between the cuff and the antecubital fossa.

- Readings were to the nearest 2 mmHg.
- No talking was allowed while performing the measurement.

3.1.3.3 Electrocardiogram

An electrocardiogram was performed to observe any palpitations of the heart and to assess the participant's ability to perform the cycle ergometer fitness test without relative risk of problems. A Cardioline Delta 60 Plus (Cardioline, San Diego, USA) electrocardiograph and Cardioline Quick ECG electrodes were used. Any participants who had any abnormalities in heart function were excluded from this study.

Implementation:

- Participants were instructed to only wear underwear and were given a blanket to cover themselves with during the procedure.
- Participants lay on a bench with the arms relaxed down the sides and were instructed not to move while performing the measurement.
- The skin on the attachment sites was sterilized and shaved if need be.
- Four electrodes were placed on the following of the appendixes: RA = on the inside of the right arm, above wrist. LA = on the inside of the left arm, above wrist. RL = on the inside of the right foot, above the ankle. LL = on the inside of the left foot, above the ankle.
- Six electrodes were placed on the following sites of the upper torso: red = at the sternal edge on the right side of the body 4th intercostals space (ICS). Yellow = at the sternal edge on the left side of the body 4th ICS. Blue = at the mid-clavicular line on the left side of the body 5th ICS. Purple = at the mid-axillary line on the left side of the body 5th ICS. Green = between Yellow and Blue. Orange = Between Blue and Purple.
- The Electrocardiograph (ECG) was programmed at 20 Hz, 25mm/s and 10.0 mm/mV.

3.1.4 Cycle ergometer fitness test

This study did not directly measure VO_2max through an open-circuit spyrometry as is the golden method. Rather fitness was measured in watts/kg bodyweight with a stationary bicycle ergometer and then later converted into VO_2max by using the following formula by Golding et al. (1989) so as to better compare fitness to other studies:

$$VO_2max = ((\text{Workload (W)} / \text{Bodyweight (kg)}) * 10.8) + 3.5 + 3.5$$

During the fitness test, which was performed by a heart specialist with the aid of the master student, the participant was wearing six electrodes on his upper torso that were connected to an electrocardiograph. The procedure for the attachment of the electrodes can be seen in the section that preceded this one. Four other electrodes were then connected to the following sites:

- One electrode was placed on each anterior deltoid at the clavicular region.
- One electrode was placed on each side of the anterior iliac crest.

The placement of the electrodes was done so as to follow any abnormalities in heart function during the test.

The ergometer bicycle was an Ergoselect 100P (Ergoline GmbH, Bitz, Germany), connected to a computer running the 6.17 release of Cardioline Prima Manager (Cardioline, San Diego, USA) programmed to a 50/50 W protocol.

Implementation:

- Participant was instructed to lie on his back relaxing while a resting electrocardiogram was processed.
- Blood pressure was measured at rest as reported earlier.
- The participant sat on the ergometer bicycle and was asked to cycle at a level speed of 60 rpm while he starts at a resistance of 50W, and the resistance was increased by 50 W each minute.
- Blood pressure was measured every two minutes.
- The participant stopped upon reaching maximal exertion or when the heart specialist decided that it was not safe to continue the test.
- To calculate fitness ($VO2_2max$) the equation by Golding et al. (1989) was used as explained earlier.

3.1.5 Questionnaires

3.1.5.1 Icelandic Quality of Life questionnaire (IQL)

The IQL questionnaire has been approved for use in research in Iceland (Helgason et al. 1997 and Helgason et al. 2000). The questionnaire can be seen in full in supplement 5. The IQL questionnaire consists of thirty-two questions that concern the twelve aspects of quality of life. The aspects are: General health, depression, social functioning, financial status, energy, anxiety, physical health, self-control, sleep, general well-being, cognition, and pain. In each question there are three, five or six possible answers, except in the visual analogue questions where there are ten possible answers. For each aspect of quality of life there are two to five questions.

By using an online situated application (Bjornson, 2014) for processing the data, T-scores are obtained. A T-score of 50 is considered average and standard deviations (SD) are considered at 10, e.g. a T-score of 40 is considered being 1 SD below average.

3.1.5.2 Questionnaire of the Icelandic Heart Association

Data on physical activity was obtained by a standard questionnaire administered by the Icelandic heart Association. Physical activity was defined as a conscious physical behaviour to improve health lasting for ≥1 hours per week. The same questionnaire asked questions regarding medication use, family history of diabetes, heart- and circulatory diseases, as well as smoking status.

3.2 Statistical analysis

All statistical analysis was conducted using SAS version 9.4 for windows (SAS Institute Inc., Cary, NC, USA).

When studying the changes in a number of various health related factors in fishermen, between 2007 and 2013 an Ancova test was performed. All variables were adjusted for age, physical activity, BMI and smoking status, as these have been reported to affect health related variables.[21-25] Moreover variables on aerobic fitness and blood pressure were additionally adjusted for blood pressure medication, and variables on blood lipids were additionally adjusted for blood lipid medication. To determine differences between categorical values within groups and between groups a Chi-squared test was performed.

The effects of the lifestyle intervention study on physical activity adherence on a subgroup of the present study (n=23) was also investigated, and various health related factors at three time-points using a within-samples t-test. Measurements made at baseline (in 2007) and at end of follow-up (in 2013) were compared, and measurements made at post intervention (in 2008) and at end of follow-up were compared. The intervention- and the control group were examined separately. One participant in the intervention group and one in the control group had incomplete data and were only used in the Ancova test.

Lastly, we explored whether there was a difference in health related factors between the intervention group and a pooled control group, during six years of follow-up using Ancova test. The pooled control group consisted of the 11 fishermen from the control group from the previous interventions and the 42 fishermen who had not previously participated. All variables were adjusted for age, physical activity, BMI, and smoking status. Moreover variables on aerobic fitness and blood pressure were additionally adjusted for blood pressure medication and variables on blood lipids were additionally adjusted for blood lipid medication. To determine differences between categorical values within groups and between groups a Chi-squared test was performed. P-values in analyses were two-sided.

4 Results

4.1 Anthropometric measurements, blood related values, physical fitness, prevalence of overweight and obesity and self-reported health related values

4.1.1 Icelandic fishermen

Physical characteristics of the Icelandic fishermen in 2013, and a comparison of various health related factors in fishermen between 2007 and 2013 can be seen in table 10.

When comparing health related factors of fishermen the measurement of aerobic fitness showed significantly higher values in 2007 compared with six years later, when adjusting for age, body mass index, physical activity and smoking status. However the number of individuals who reported being physically active (≥1 hours./week) was higher in 2013 (19% vs. 34%, p=.030), and there was a decline in individuals who smoke (≥1 cigarettes/day; 39% vs. 23%, p=.063). Diastolic blood pressure, total cholesterol, Low-density lipoprotein and fasting glucose were significantly higher in the fishermen in 2013 compared with the measurements in 2007.

Table 10. Anthropometric measurements, blood values, blood pressure, physical fitness, prevalence of overweight and obesity and various self-reported health related factors of Icelandic fishermen in 2007 and 2013

Variable	2007 (N=62)	2013 (N=77)[f]	% diff[β]	*P*-value
Age (years)	41.2 ± 1.2	44 ± 1.1	6.7	0.113[d]
Height (cm)	178.6 ± 0.8	180.1 ± 0.7	0.8	0.189[d]
Weight (kg)	88.8 ± 0.8	90.5 ± 0.7	1.9	0.141[d]
BMI (Kg/m^2)	27.2 ± 0.6	28.2 ± 0.5	3.6	0.243[d]
Waist circumference (cm)	97.8 ± 0.5	98.7 ± 0.4	0.9	0.285[d]
%BF	25 ± 0.3	25.6 ± 0.3	2.4	0.303[d]
SBP (mmHg)[b]	123.7 ± 1.5	127.4 ± 1.3	2.9	0.087[d]
DBP (mmHg)[b]	76.8 ± 1.0	80.7 ± 0.9	5	0.007[d]
HDL (mmol/L)[a]	1.42 ± 1.42	1.40 ± 1.40	1.4	0.762[d]
LDL (mmol/L)[a]	3.03 ± 0.11	3.51 ± 0.11	15.8	0.006[d]
Triglycerides (mmol/L)[a]	1.08 ± 1.08	1.02 ± 1.02	5.5	0.480[d]
Total Cholesterol (mmol/L)[a]	4.94 ± 0.11	5.38 ± 0.11	8.9	0.011[d]
Glucose (mmol/L)	5.12 ± 0.05	5.35 ± 0.05	4.4	0.005[d]
Aerobic fitness (W/kg)	2.7 ± 0.04	2.5 ± 0.03	7.4	0.015[d]
VO_2max ($mL*kg^{-1}*min$)	36.16 ± 7.43	34 ± 7.43	5.9	–
Overweight individuals (BMI ≥25 Kg/m^2), n (%)	45 (72.5)	64 (83.1)	42.2	0.150[e]
Obese individuals (BMI ≥30 Kg/m^2), n (%)	12 (19.3)	21 (27.2)	75	0.946[e]
Self-reported data				
Individuals who are physically active (≥1 hrs./week), n (%)	12 (19.3)	26 (33.7)	116.6	0.030[e]
Individuals who smoke (≥1 cigarettes/day), n (%)	24 (38.7)	18 (23.3)	25	0.063[e]
Individuals with diagnosed diabetes, n (%)	1 (1.61)	1 (1.3)	–	1.000[e]
Individuals using blood lipid medication, n (%)	0 (0)	6 (7.7)	600	0.032[e]
Individuals using blood pressure medication, n (%)	5 (8)	15 (19.4)	200	0.087[e]

Numbers in Age through Aerobic fitness are means with SD. Variables Height through Aerobic fitness, are adjusted for age, physical activity, BMI and smoking status. Abbreviations; BMI, body mass index; %BF, body fat percentage; SBP, systolic blood pressure; DBP, diastolic blood pressure; HDL, high-density lipoprotein; LDL, low-density lipoprotein. VO^2max ($mL*kg^{-1}*min$) was calculated using the equation from Golding et al. (1989). [a] Adjusted for blood lipid medications. [b] Adjusted for blood pressure medications. [β] Percentage difference. [d] P-value determined by an ANCOVA test. [e] P-value determined by a Chi-squared test. [f] This number includes 23 fishermen that participated in the intervention group.

4.1.2 Intervention group

Health related measurements were conducted three times during the study period for 23 men in the intervention group of the study (data of one participant was incomplete and was not used in this analysis). Table 11 shows data from the measurements at baseline, post-intervention and end of follow-up. Between post-intervention and end of follow-up a significant increase was observed in weight, body mass index, systolic blood pressure, diastolic blood pressure, body fat percentage, waist circumference, total cholesterol, low-density lipoprotein and fasting glucose. Aerobic fitness had significantly decreased by 14% during the 6 years after the intervention. Prevalence of overweight had not changed during the six years but prevalence of obesity had relatively increased from 13% to 17% (p=.811).

Reported physical activity had not changed between baseline and end of follow-up with 39% reporting being physically active. Smoking had relatively decreased between baseline and end of follow-up (26% vs. 17%, p=.722).

4.1.3 Control group

Health related measurements conducted three times during the study period were available for 10 participants in the control group (table 12). Between post-intervention to the end of follow-up a significant increase was observed in systolic blood pressure, diastolic blood pressure, body fat percentage, waist circumference and high-density lipoprotein.

Table 11. Anthropometric measurements, blood values, blood pressure, physical fitness, prevalence of overweight and obesity and various self-reported health related factors in 2007, 2008 and in 2013 for the intervention group

Variable	2007 (n=23)	2008 (n=23)	2013 (n=23)	% change[β]	*P*-value[Ŧ]	% change[µ]	*P*-value[ϒ]
Age (Years)	41.7	42 ± 10	47.1 ± 9.9	12.9	<.0001[a]	12.1	<.0001[a]
Height (cm)	180.1 ± 6.6	180.1 ± 6.8	179.9 ± 6.8	0.1	0.06[a]	0.1	0.096[a]
Weight (kg)	87.4 ± 10.1	86.3 ± 10	90.1 ± 12.8	3	0.05[a]	4.4	0.011[a]
BMI (Kg/m²)	26.9 ± 2.6	26.5 ± 2.5	27.8 ± 3.1	3.3	0.047[a]	4.9	0.007[a]
Waist circumference (cm)	97.2 ± 7.3	96.8 ± 7.5	99.6 ± 9.5	2.4	0.068[a]	2.8	0.022[a]
%BF	24.6 ± 4.8	23.8 ± 4.6	26.8 ± 5.3	8.9	0.010[a]	12.6	.0003[a]
SBP (mmHg)	124 ± 13	122.4 ± 9.22	128.2 ± 11	3.3	0.047[a]	4.7	0.040[a]
DBP (mmHg)	76.8 ± 9.9	73.8 ± 6	83.3 ± 7.7	8.4	.0003[a]	12.8	<.0001[a]
HDL (mmol/L)	1.40 ± 0.28	1.51 ± 0. 38	1.40 ± 0.34	–	0.390[a]	7.2	0.615[a]
LDL (mmol/L)	3.09 ± 0.70	2.98 ± 0.78	3.53 ± 0.65	14.2	0.194[a]	18.4	0.002[a]
Triglycerides (mmol/L)	1.20 ± 0.38	0.99 ± 0.46	1.01 ± 0.44	15.8	0.001[a]	2	0.625[a]
Total Cholesterol (mmol/L)	5.05 ± 0.82	4.95 ± 0.74	5.4 ± 0.69	6.9	0.296[a]	9	0.003[a]
Glucose (mmol/L)[a]	5.09 ± 0.28	5.11 ± 0.5	5.46 ± 0.49	7.2	0.014[a]	6.8	0.006[a]
Aerobic fitness (W/kg)	2.7 ± 0.3	2.8 ± 0.4	2.4 ± 0.4	11.1	.0002[a]	14.2	<.0001[a]
VO_2max (mL*kg^{-1}*min)	36.1 ± 10.2	37.2 ± 11.3	32.9 ± 11.3	8.9	–	11.6	–
Overweight individuals (BMI ≥25 Kg/m²), n (%)	20 (86.9)	–	20 (86.9)	–	1.000[b]	–	–
Obese individuals (BMI ≥30 Kg/m²), n (%)	3 (13)	–	4 (17.3)	33.3	0.811[b]	–	–
			Self-reported data				
Individuals who are physically active (≥1 hrs./week), n (%)	9 (39.1)	–	9 (39.1)	–	1.000[b]	–	–
Individuals who smoke (≥1 cigarettes/day), n (%)	6 (26.1)	–	4 (17.3)	33.3	0.722[b]	–	–
Individuals with diagnosed diabetes, n (%)	0 (0)	–	0 (0)	–	1.000[b]	–	–
Individuals using blood lipid medication, n (%)	0 (0)	–	2 (8.7)	200	0.488 [b]	–	–
Individuals using blood pressure medication, n (%)	0 (0)	–	7 (30.4)	700	0.009 [b]	–	–

Numbers in Age through Aerobic fitness are means with SD. 2007, pre-intervention; 2008, post-intervention; 2013, follow-up. Abbreviations; BMI, body mass index; %BF, body fat percentage; SBP, systolic blood pressure; DBP, diastolic blood pressure; HDL, high-density lipoprotein; LDL, low-density lipoprotein. VO^2max (mL*kg^{-1}*min) was calculated using the equation from Golding et al. (1989). [a] Differences between groups determined from within-samples t-test. [b] P-values determined by a chi-squared test between the years 2007 and 2013. [β] Percentage change between 2007 and 2013. [µ] Percentage change between 2008 and 2013. [Ŧ] P-values indicate differences between 2007 and 2013. [ϒ] P-values indicate differences between 2008 and 2013. Dashes indicate values that were not obtained at post-intervention.

Table 12. Anthropometric measurements, blood values, blood pressure, physical fitness, prevalence of overweight and obesity and various self-reported health related factors in 2007, 2008 and in 2013 for the control group

Variable	2007 (n=10)	2008 (n=10)	2013 (n=10)	% change[β]	*P*-value[ŧ]	% change[μ]	*P*-value[ϒ]
Age (Years)	41.2 ± 5.6	41.7 ± 5.6	47.1 ± 5.5	14.3	<.0001[a]	12.9	<.0001[a]
Height (cm)	177.5 ± 6.5	178 ± 6.3	177.8 ± 6.3	0.16	0.131[a]	0.1	0.508[a]
Weight (kg)	82.1 ± 12.5	83 ± 13.4	84.9 ± 12.4	3.4	0.002[a]	2.2	0.097[a]
BMI (Kg/m^2)	26 ± 3.7	26.2 ± 4.1	26.8 ± 3.7	3	0.004[a]	2.2	0.093[a]
Waist circumference (cm)	92.5 ± 8	92.7 ± 8.8	96.6 ± 9.1	4.4	0.003[a]	4.2	0.012[a]
%BF	21.7 ± 6.2	21.9 ± 7	24.4 ± 6.9	12.4	.0001[a]	11.4	0.006[a]
SBP (mmHg)	118 ± 10.8	115.2 ± 11.2	121.6 ± 11	3	0.137[a]	5.5	0.029[a]
DBP (mmHg)	72.4 ± 9.6	73 ± 8.1	77.4 ± 8.3	6.9	0.071[a]	6	0.052[a]
HDL (mmol/L)	1.55 ± 0.28	1.40 ± 0.29	1.55 ± 0.24	-	0.986[a]	10.7	0.013[a]
LDL (mmol/L)	2.65 ± 0.72	3.22 ± 0.91	3.09 ± 0.81	16.6	0.005[a]	4	0.751[a]
Triglycerides (mmol/L)	0.91 ± 0.47	0.92 ± 0.31	0.82 ± 0.33	9.8	0.552[a]	10.8	0.948[a]
Total Cholesterol (mmol/L)	4.61 ± 67	5.05 ± 0.96	5.02 ± 0.83	8.8	0.029[a]	0.5	1.000[a]
Glucose (mmol/L)[a]	5.07 ± 0.41	4.88 ± 0.55	5.22 ± 0.31	2.9	0.188[a]	6.9	0.343[a]
Aerobic fitness (W/kg)	2.8 ± 0.3	2.8 ± 0.4	2.6 ± 0.3	7.1	0.014[a]	7.1	0.224[a]
VO_2max (mL*kg^{-1}*min)	37.2 ± 10.2	37.2 ± 11.3	35 ± 10.2	5.8	–	5.8	–
Overweight individuals (BMI ≥25 Kg/m^2) , n (%)	6 (60)	–	7 (70)	16.6	1.000[b]	–	–
Obese individuals (BMI ≥30 Kg/m^2) , n (%)	2 (20)	–	2 (20)	–	1.000[b]	–	–
		Self-reported data					
Individuals who are physically active (≥1 hrs./week), n (%)	1 (10)	–	3 (30)	200	0.582[b]	–	–
Individuals who smoke (≥1 cigarettes/day), n (%)	4 (40)	–	2 (20)	50	0.628[b]	–	–
Individuals with diagnosed diabetes, n (%)	1 (10)	–	1 (10)	–	1.000[b]	–	–
Individuals using blood lipid medication, n (%)	0 (0)	–	1 (10)	100	1.000[b]	–	–
Individuals using blood pressure medication, n (%)	1 (10)	–	0 (0)	100	1.000[b]	–	–

Numbers in Age through Aerobic fitness are means with SD. 2007, pre-intervention; 2008, post-intervention; 2013, follow-up. Abbreviations; BMI, body mass index; %BF, body fat percentage; SBP, systolic blood pressure; DBP, diastolic blood pressure; HDL, high-density lipoprotein; LDL, low-density lipoprotein. VO^2max (mL*kg^{-1}*min) was calculated using the equation from Golding et al. (1989). [a]Differences between groups determined from within-samples t-test. [b]P-values determined by a chi-squared test between the years 2007 and 2013. [β] Percentage change between 2007 and 2013. [μ] Percentage change between 2008 and 2013. [ŧ] P-values indicate differences between 2007 and 2013. [ϒ] P-values indicate differences between 2008 and 2013. Dashes indicate values that were not obtained at post-intervention.

4.1.4 Intervention group versus a pooled control group in 2013

In table 13 a comparison of measurements between the intervention and the pooled control group in the year 2013 can be seen. The 11 fishermen in the previous control group and the 42 fishermen who had not previously participated were pooled into a combined control group, to increase the power of the statistical analysis, as there was no difference between the intervention group and the control group from 2007 (n=11). The pooled control group was then compared to the 24 fishermen who participated in the previous intervention and in this study.

The intervention group was older (4.5 years on average) and reported being more physically active than the pooled control group (42% vs. 30%, p=.058). Also the intervention group had a lower prevalence of obesity (17% vs. 32%, p=.046) and a relative lower prevalence of smoking (17% vs. 26%, p=.400) compared with the pooled control group. When adjusting for age, body mass index, physical activity and smoking status mean values for fasting blood glucose were significantly higher in the intervention group compared with the pooled control group, no other difference between the two groups was observed. No significant differences were found between the two control groups.

Table 13. Anthropometric measurements, blood values, blood pressure, physical fitness, prevalence of overweight and obesity and various self-reported health related factors in 2013

Variable	Intervention group (n=24)	Pooled Control Group (n=53)	% diff.[β]	*P*-value
Age (years)	47.1 ± 1.8	42.6 ± 1.2	9.5	0.058[d]
Height (cm)	180.8 ± 1.2	179.5 ± 0.8	0.7	0.372[d]
Weight (kg)	92.6 ± 1.2	91.3 ± 0.8	1.4	0.380[d]
BMI (Kg/m^2)	27.9 ± 0.8	28.4 ± 0.5	1.7	0.718[d]
Waist (cm)	100.9 ± 0.8	99.3 ± 0.5	1.5	0.129[d]
%BF	27.2 ± 0.6	25.9 ± 0.4	4.7	0.114[d]
SBP (mmHg)	126.9 ± 2.5	128.8 ± 1.7	1.4	0.558[d]
DBP (mmHg)	81.9 ± 1.5	81.5 ± 1.0	0.4	0.837[d]
HDL (mmol/L)[a]	1.39 ± 0.09	1.40 ± 0.05	0.7	0.972[d]
LDL (mmol/L)[a]	3.51 ± 0.25	3.50 ± 0.15	0.2	0.954[d]
Triglycerides (mmol/L)[a]	1.01 ± 0.11	1.08 ± 0.06	6.9	0.650[d]
Total Cholesterol (mmol/L)[a]	5.34 ± 0.24	5.39 ± 0.15	1.4	0.963[d]
Glucose (mmol/L)	5.55 ± 0.11	5.28 ± 0.06	4.9	0.045[d]
Aerobic fitness (W/kg)	2.5 ± 0.07	2.5 ± 0.05	0	0.635[d]
VO_2max ($mL*kg^{-1}*min$)	34 ± 7.7	34 ± 7.5	0	–
Overweight individuals (BMI ≥25 Kg/m^2), n (%)	21 (87.5)	43 (81.1)	104.7	0.743[e]
Obese individuals (BMI ≥30 Kg/m^2), n (%)	4 (16.6)	17 (32)	325	0.046[e]
	Self-reported data			
Individuals who are physically active (≥1 hrs./week), n (%)	10 (41.6)	16 (30.1)	60	0.435[e]
Individuals who smoke (≥1 cigarettes/day), n (%)	4 (16.6)	14 (26.4)	240	0.400[e]
Individuals with diagnosed diabetes, n (%)	0 (0)	1 (1.8)	100	1.000[e]
Individuals using blood lipid medication, n (%)	2 (8.3)	4 (7.5)	100	1.000[e]
Individuals using blood pressure medication, n (%)	8 (33.3)	7 (13.2)	12.5	0.060[e]

Variables Height through Aerobic fitness are adjusted for age, physical activity, BMI and smoking status. Numbers in Age through Aerobic fitness are means with SD. Abbreviations; BMI, body mass index; %BF, body fat percentage; SBP, systolic blood pressure; DBP, diastolic blood pressure; HDL, high-density lipoprotein; LDL, low-density lipoprotein. VO^2max ($mL*kg^{-1}*min$) was calculated using the equation from Golding et al. (1989). **[a]** Adjusted for blood lipid medications. **[b]** Adjusted for blood pressure medications. [β] Differences in percentages. [d] P-value determined by a ANCOVA test. **[e]** P-value determined by a Chi-squared test.

4.2 Quality Of Life measurements

4.2.1 Icelandic fishermen

QOL subscale characteristics of the Icelandic fishermen in 2013, and a comparison of subscale factors in fishermen between 2007 and 2013 can be seen in table 14.

When comparing QOL subscales of fishermen, there were no significant differences between the pre-intervention and end of follow-up.

Table 14. Quality Of Life subscales of Icelandic fishermen in 2007 and 2013

Subscale	2007 (N=62)	2013 (N=77)[B]	*P*-value
General health	48.8 ± 7.3	47.5 ± 8.2	0.364[A]
Depression	51.28 ± 6	51.23 ± 9.5	0.973[A]
Social functioning	52.4 ± 6.8	53 ± 7	0.942[A]
Financial status	55.1 ± 5.5	52.7 ±7.7	0.818[A]
Energy	51 ± 5.2	49.8 ± 7.8	0.141[A]
Anxiety	49.2 ± 7	50.5 ± 10	0.944[A]
Physical health	49.7 ± 8.5	49.3 ± 8.3	0.981[A]
Self-control	50.5 ± 6.7	48.7 ± 10	0.865[A]
Sleep	47.1 ± 9.7	47.1 ± 10	0.993[A]
General well-being	52.6 ± 6	52.6 ± 8.1	0.951[A]
Cognition	50.9 ± 7.5	49.4 ± 8.5	0.986[A]
Pain	46.9 ± 11	52.8 ± 9.4	0.994[A]
QOL	51.3 ± 5.7	50.9 ± 7.7	0.992[A]

Numbers are means with SD. All variables have been adjusted for age, physical activity, BMI and smoking status. Abbreviations: QOL, Quality Of Life. [A]P-value determined with an ANCOVA test. [B]This number includes 23 fishermen who participated in the intervention group.

4.2.2 Intervention group

QOL measurements were conducted three times during the study period for 23 men in the intervention group of the study (data of one participant was incomplete and was not used in this analysis). Table 15 shows data from the measurements at baseline, post-intervention and end of follow-up.

There was no statistically significant difference in measurements between pre-intervention and end of follow-up, expect in social functioning (p=.044) and pain (p=.041). There was no statistically significant difference between post-intervention and end of follow-up.

Table 15. Quality Of Life subscales in 2007, 2008 and 2013 in the intervention group

Subscale	2007 (n=23)	2008 (n=23)	2013 (n=23)	*P*-value[1]	*P*-value[2]
General health	48.2 ± 7.1	47.3 ± 7.9	46.9 ± 9.5	0.430[A]	0.599[A]
Depression	49.6 ± 6.4	51.5 ± 6.2	53.2 ± 5.4	0.105[A]	0.364[A]
Social functioning	50.2 ± 5.2	53.1 ± 6.4	54.1 ± 5.6	0.044[A]	0.492[A]
Financial status	42.4 ± 5.9	53.6 ± 4.9	55.5 ± 5.3	0.095[A]	0.165[A]
Energy	50 ± 4	50.3 ± 7.3	51.7 ± 5.8	0.267[A]	0.356[A]
Anxiety	47.7 ± 8.6	50 ± 9.6	50.3 ± 8.6	0.208[A]	0.867[A]
Physical health	45.9 ± 9	49.1 ± 5.8	48.1 ± 9.1	0.415[A]	0.605[A]
Self-control	48.2 ± 7.1	49.6 ± 8.5	51.1 ± 5.7	0.197[A]	0.425[A]
Sleep	43.9 ± 10.7	46 ± 9.1	46.3 ± 10	0.413[A]	0.911[A]
General well-being	51 ± 4.9	52.6 ± 5.8	52.2 ± 6.9	0.608[A]	0.892[A]
Cognition	47.6 ± 7.5	48.6 ± 8.5	49.3 ± 8.2	0.624[A]	0.737[A]
Pain	44.5 ± 10.7	49 ± 8.9	50.2 ± 9.6	0.041[A]	0.606[A]
QOL	48.6 ± 4.8	50.9 ± 6.2	51.7 ± 4.8	0.069[A]	0.590[A]

Numbers are means with SD. [1]P-values indicate differences between 2007 and 2013. [2]P-values indicate differences between 2008 and 2013. [A]P-value between groups determined with a within-sample t-test. 2007, pre-intervention; 2008, post-intervention; 2013, follow-up.

4.2.3 Control group

Health related measurements conducted three times during the study period were available for 10 participants in the control group (table 16). Between pre-intervention to the end of follow-up no significant differences were found. Between post-intervention to the end of follow-up a significant increase was observed in social functioning (p=.049), physical health (p=.042), general well-being (p=.047), and QOL (p=.052).

Table 16. Quality Of Life subscales in 2007, 2008 and 2013 in the control group

Subscale	2007 (n=11)	2008 (n=11)	2013 (n=11)	*P*-value[1]	*P*-value[2]
General health	47.5 ± 5.8	51.1 ± 5.1	51.6 ± 3.8	0.065[A]	0.738[A]
Depression	55.6 ± 3.9	54 ± 5.3	53.1 ± 6.2	0.126[A]	0.514[A]
Social functioning	57.8 ± 3.6	53.7 ± 3.4	57.1 ± 2.9	0.672[A]	0.049[A]
Financial status	57.2 ± 3.4	51.6 ± 8.5	53.3 ± 6.5	0.066[A]	0.416[A]
Energy	53.1 ± 3.5	50.2 ± 6.9	52.5 ± 6.3	0.736[A]	0.499[A]
Anxiety	50.6 ± 4.2	51.2 ± 6.6	52.6 ± 9.5	0.547[A]	0.475[A]
Physical health	53.7 ± 4.1	51.6 ± 6.5	55 ± 4.5	0.606[A]	0.042[A]
Self-control	53.2 ± 5	52.5 ± 5.3	52.3 ± 59	0.518[A]	0.935[A]
Sleep	53.1 ± 5.4	51.2 ± 5	52.6 ± 7	0.893[A]	0.768[A]
General well-being	56 ± 3.3	53.7 ± 3.3	57.8 ± 4.6	0.249[A]	0.047[A]
Cognition	54 ± 5.8	53.1 ± 7	52.5 ± 7.7	0.544[A]	0.844[A]
Pain	48 ± 12.8	50 ± 7.9	52.7 ± 7.6	0.431[A]	0.400[A]
QOL	55.2 ± 3.1	52.5 ± 4.9	55.2 ± 4.6	1.000[A]	0.052[A]

Numbers are means with SD. [1]P-values indicate differences between 2007 and 2013. [2]P-values indicate differences between 2008 and 2013. [A]*P*-value between groups determined with a within-sample t-test. 2007, pre-intervention; 2008, post-intervention; 2013, follow-up.

4.2.4 Intervention group versus a pooled control group in 2013

In table 17 a comparison of measurements between the intervention and the pooled control group in the year 2013 can be seen. No significant differences were found between the two control groups.

When adjusting for age, body mass index, physical activity and smoking status, no statistical differences were found between mean values of the intervention group and the pooled control group, except in self control (p=.042).

Table 17. Quality Of Life subscales of the intervention group and a pooled control group in 2013

Subscale	Intervention group (n=24)	Pooled control group (n=53)	*P*-value
General health	46.7 ± 9.1	48 ± 7.8	0.485[A]
Depression	53.6 ± 5.2	49.6 ± 10.9	0.129[A]
Social functioning	55 ± 5.7	52.1 ± 7.4	0.136[A]
Financial status	55.5 ± 4.9	52 ± 8.5	0.089[A]
Energy	50.8 ± 6.1	49.6 ± 8.3	0.582[A]
Anxiety	52.1 ± 8.5	49.9 ± 10.7	0.417[A]
Physical health	48.9 ± 8.7	49.5 ± 8.1	0.773[A]
Self-control	52.3 ± 5.7	47.1 ± 10	0.042[A]
Sleep	47.9 ± 9.8	46.5 ± 10.1	0.610[A]
General well-being	53.7 ± 7	52 ± 8.7	0.457[A]
Cognition	50.5 ± 8.6	49 ± 8.5	0.533[A]
Pain	50.5 ± 9.6	53.1 ± 9.2	0.327[A]
QOL	52.5 ± 4.9	50.2 ±8.8	0.297[A]

Numbers are means with SD. All variables have been adjusted for age, physical activity, BMI and smoking status. Abbreviations: QOL, Quality Of Life. [A]P-value determined with an ANCOVA test.

5 Discussion

There were three aims of this thesis. Our first objective was to explore the changes in a number of health related factors of Icelandic fishermen during a period of six years. The answer to this is that we observed a worsening of the conditions in a number of health related factors in Icelandic fishermen during six years of follow up. Positively physical activity had increased and smoking had decreased at the same time.

The second objective was to use data on a subgroup of the study, to investigate the effects of the previous lifestyle intervention study on physical activity adherence, and various health related factors at three time-points over a period of six years. The answer to the second objective is that the positive effect of the lifestyle intervention six years earlier had mostly diminished as conditions of the health related factors had either returned to their pre-intervention state or worsened. Physical activity had not changed between baseline and end of follow-up.

Lastly the third objective was to study whether there was a difference in health related factors between the intervention group and a pooled control group six years later. The answer to this is that there was no difference between these groups except in age and higher blood glucose in the intervention group. The participants in the intervention group were more physically active, had a lower prevalence of obesity and a relative lower prevalence of smoking, which might indicate better health literacy in this group.

5.1 Anthropometric measurements, blood related values, physical fitness, prevalence of overweight and obesity and self-reported health related values

5.1.1 Icelandic fishermen

Blood pressure of the Icelandic fishermen was on average prehypertensive or high-normal, according to current definitions (Chobanian et al, 2003). The systolic blood pressure was especially high. This indicates a grave situation for the fishermen to be in, as clinically healthy disease-free adults, as prehypertension is an adverse cardiometabolic risk profile (Gupta et al, 2010). Possibly, if nothing is done, the situation will grow worse and the state of the participants could worsen to a life threatening state. Systolic hypertension is the most common form of hypertension and the global rate of diagnosis is rising rapidly (Kannel, 2000). It has been shown that a 10 mmHg rise in systolic blood pressure increases the risk of all fatal and non-fatal complications, except coronary events, by nearly 10% (Staessen et al, 2000). Increased levels of physical activity and physical fitness have been shown to decrease blood pressure (Olafsdottir et al, 2012, Chobanian et al, 2003).

Total cholesterol and Low-density lipoprotein of the participants measured in 2013 were on average borderline high despite the higher medication use. (National Cholesterol Educational Program 2002, American Diabetes Association, 2004). Also their fasting glucose was higher in 2013 than in 2007 although the average value was not above the level for classification of diabetes (American Diabetes Association, 2004). Lowering cholesterol and LDL requires individuals to regulate their diets so as not to have too much saturated fats and cholesterol in their foods, and maintain regular physical activity (National Cholesterol Educational Program, 2002). Also blood glucose can improve by regular physical activity (Haskell et al, 2007) and it has been shown that aerobic fitness and mortality are inversely related in men with diabetes (Church et al, 2004).

More Icelandic fishermen reported being physically active in 2013 compared with 2007 (34% vs. 19%), which is higher than what was reported in Europe in 2009 (Nichols et al, 2012). It is likely that our participants were including work related physical activity in their self-assessment of physical activity. This would have led to an overestimation of their reported physical activity which was defined as a conscious physical behaviour to improve health lasting for ≥1 hours per week.

There was a borderline significant 25% fewer fishermen who smoked (≥1 cigarettes/day) in 2013 compared with fishermen in 2007. So it seems that the fishermen have improved their health literacy, which is associated with being a non-smoker (Wagner et al, 2007) Increases in physical activity have previously been linked with decreased smoking, showing a trend in improved health literacy with increased physical activity (DeReuter et al, 2014, Winnail et al, 2009).

Aerobic fitness of all the Icelandic fishermen in 2013 was according to Golding et al. (1989) on average 34 VO_2max $mL*kg^{-1}*min^{-1}$, which is poor for 40-49 year old males (Fletcher et al, 1990). Aerobic fitness was not expected to decline to such an extent. As aerobic fitness was lower in 2013 compared with six years earlier it indicates that the fishermen were either not participating in activities that improve aerobic fitness or that they exaggerated their reported physical activity in 2013. Report failure and exaggeration has been reported in another study (Troiano et al, 2008).

Possibly the exaggeration is due to the health education the fishermen in the intervention group received in 2007, and that due to their knowledge of the importance of physical activity they exaggerated their self-reported physical activity. Also smoking has been linked with decreased aerobic fitness (Suminski et al, 2009), and as physical activity was more prevalent and smoking was less prevalent in 2013 compared with six years earlier it would have been expected that aerobic fitness in 2013 was either higher or at least level with that reported six years earlier. It is of interest that their fitness is not much different from that of left ventricular contractile dysfunction patients (Ehsani et al, 1985). Moreover, decreased VO_2max has been suggested as an early indicator of insulin resistance syndrome and type 2 diabetes and may be an important risk factor in the progression of these diseases (Leite et al, 2009). The decreases in the health related measurements from post-intervention to end of follow-up may partly be because of the decreases in aerobic fitness.

5.1.2 Intervention group

The body mass index of the participants in the intervention group had increased, and their average value was classified as overweight (National Institutes of Health, 1998). Their average body fat percentage was high (Gallagher, et al, 2000), and had increased during follow-up. It seems that the increased body mass index score is not due to muscular increase but rather fat increase. This might further increase their health risk and decrease their ability to perform their work. Increased overweight among fishermen has been reported before (Skrobonja et al, 1998, Hansen et al, 2011, Ólafsdóttir, 2004), indicating a general trend in this occupation that seems mostly to come from inactivity and poor dietary habits. Also, because of this lifestyle, fishermen have a higher risk of hospitalization due to lifestyle-related risks (Kaerlev et al, 2007). The trend of increased body mass index between 2007 and 2012 follows the general trend of Icelandic males (Icelandic Nutritional Council, 2004).

The participants in the intervention group were classified as having high-normal blood pressure, which is just below hypertension (Chobanian et al, 2003). Individuals who have a high-normal blood pressure are at increased risk of CHD compared with individuals who have normal blood pressure (Gupta et al, 2010). Blood pressure can be favourably modified by physical activity and increased fitness (US Department of Health and Human Services, 1996, Grundy et al, 1999, Chobanian et al, 2003).

Total cholesterol was borderline high (National Cholesterol Educational Program 2002) increasing the risk of disease. LDL cholesterol levels of the participants in the intervention group had increased to borderline high between post-intervention and end of follow-up.

The aerobic fitness of the participants in the intervention group in 2013 had on average statistically significantly decreased from the year 2008 even though participants reported no change in physical activity. According to Golding et al. (1989), their VO_2max was 33 $mL*kg^{-1}*min^{-1}$ in 2013 which is below average for 40-49 year old males (Fletcher et al, 1990). As discussed in chapter 5.1.1 there are indications that the participants in the intervention group were not participating in physical activity that improve aerobic fitness, or that there was an exaggeration of physical activity. The increased blood pressure of the intervention group is a further indication of this, as well as the increased cholesterol and LDL as these have been shown to improve with increased physical activity and aerobic fitness (US Department of Health and Human Services, 1996, Grundy et al, 1999, National Cholesterol Educational Program 2002 Chobanian et al, 2003).

5.1.3 Intervention group versus a pooled control group in 2013

Interestingly there was no statistical difference between the intervention group from 2007 and the fishermen that only participated at follow-up in 2013 (n=42) except in fasting glucose concentrations and blood pressure medications. We raised some questions to whether the effects might be more latent than believed. It is possible that the intervention from 2007 has had some protective effects against age-related decline in health which has been reported before (DeSouza et al, 2000, McGuire et al, 2001, Steward, 2005, Rovia et al, 2005, Gudlaugsson et al, 2012. The positive effects of physical activity on health are well known and thus it is possible that the health of the intervention group would have been worse at the end of follow-up if they had not participated in the intervention study.

5.2 Quality Of Life measurements among Icelandic fishermen

QOL of all the fishermen is slightly over the norm reported in Icelandic males (Helgason et al, 2000). QOL is improved in individuals who are physically active (Bize et al, 2007), even if they are pre-diagnosed with a disease (Taylor et al, 2010) or classified as overweight or obese (Kruger et al, 2007). It is possible that the physical activity and nutrition intervention in 2007 had a protective effect on QOL of the fishermen, as their QOL is not significantly different from pre-intervention and has apparently not been affected to the same extent by age (Brazer et al, 1992, Brorsson et al, 1993, Jenkinson et al, 1993), or working environment (Agterberg et al, 1998, Oldenburg et al, 2009, Ólafsdóttir, 2004), as reported in other studies. Happiness and well-being of Icelanders in general is high compared to other nations (Veehoven, 2011, Gudmundsdottir, 2007), which might further explain the high QOL measured among Icelandic fishermen in the present study. In Iceland the average male has a higher QOL than the average woman of the same age, and overall QOL decreases with increased age although some aspects of QOL improve with increasing age (Helgason et al, 2000).

The lowest value scored in the QOL subscales was in sleep, followed by general health, physical health and cognition. Low quality of sleep has been reported in other studies if Icelandic fishermen (Helgason et al, 1975, Ólafsdóttir, 2004, Ingvason, et al, 2005, Olafsdottir et al, 2012) demonstrating a general trend in this population. Irregular sleep patterns disturb normal psycho-physiological functions, such as the night and day rhythm (Folkard et al, 1985, Miners and Waterhouse, 1986). These patterns are often found in shift-work (Costa, 2003). The process of continuously shifting sleep patterns is stressful for the body as it tries to adjust. The results are fatigue, insomnia, poor mental ability and reduced performance (Costa, 2003). Fishermen work in shifts and follow the general trend of shift-workers, where disturbed sleep is the most common ailment (Akerstedt, 2003). Olafsdottir (2004) also reported quality of sleep to be lacking in Icelandic fishermen, especially during the day. Sleep length of 2-4 hours between shifts is common in fishermen (Ólafsdóttir, 2004). This is far below the recommended sleeping time for adults aged 26-65 years of at least 6 hours (Hirskowitz, 2015), so as to rest and refreshing. Another factor for decreasing sleep quality might be the sleeping facilities. Everything onboard ship has to be compact and space efficient at sea. The fishermen therefore sleep in bunk beds, which are not good for body position and the alignment of the spine during sleep, further decreasing sleep quality (Ólafsdóttir, 2004). Sleeping with an undesirable curvature in the spine for hours and then working for hours in an occupation where the strain on the musculoskeletal system is great, increases the chances of repetitive strain injury and other stress syndromes (Ólafsdóttir, 2004).

Quality and length of sleep is closely related to the ability to concentrate and decreased mental ability (cognition, Stahle et al, 2011). If concentration is low accidents are more likely to happen. Accidents at sea are common (Statistics Iceland, 2012), and are more difficult to deal with as medical assistance is not close by and it may take hours for assistance to arrive out at sea. Also decision making is poor during sleep deprivation (Stahle et al, 2011) which may cost lives at sea as every minute and every action is crucial if a life threatening accident happens.

QOL of all the fishermen in the intervention group is slightly over the norm reported in Icelandic males (Helgason et al, 2000). They scored highest in financial status, social functioning, depression and general well-being, some of these almost half an SD above a T-score of 50 (considered average). This indicates that their social functioning was good. Social functioning is related to degree of depression in a way that highly depressed individuals are more inclined to have worse social interactions with their peers (Nezlek, et al, 2000). Also as the participants in the intervention group had a relatively high score in social functioning and depression it indicates that the moral on-board ship is good. This is crucial to maintain social well-being.

The lowest score in a QOL subscale in 2013 in the intervention group was sleep, followed by general health, physical health and cognition. Sleep quality had not change between pre-intervention and at end of follow-up. Indicating that this is a consistent problem in this occupation. Sleep received a score of almost half an SD below average values (a T-score of 50, Helgason et al, 1997) indicating the perilous situation the fishermen are in regarding the problems with lacking sleep mentioned above.

The control group scored above average in all QOL subscales. General well-being and social functioning were especially high with general well-being almost an SD above average score.

Participation in the control group was not good, and even though the control group was not statistically different from the intervention group in both health related measurements and QOL subscales, there are some indications that the individuals in the control group who participated in this study self-selected themselves into the study because of good health. Aside from the physiological measurements where they were relatively (though not statistically) healthier than the intervention group, they scored markedly higher in most QOL subscales. Also in the previous study of the health of Icelandic fishermen (Olafsdottir et al, 2012) the control group scored markedly lower in most physiological measurements as well as in the QOL subscales post-intervention compared to the intervention group. This indicates that the individuals in the control group who agreed to participate in this study might be the healthier individuals of the control group and might skew the comparisons between groups.

Interestingly the pooled control group scored lower in most subscales of the QOL compared to the Intervention group. There was no statistically significant difference between subscales, except in self-control where there was a 10.4% difference between groups. This group also battles the same problems of sleep as discussed above.

We raised some questions to whether the effects of the intervention from 2007 might be more latent than believed. It is possible that the intervention has had some protective effects against age-related decline in QOL which has been reported before (Palgi et al, 2015)

5.3 Interventions studies, follow-up and the importance of continued guidance

This study had a long follow-up period of 6 years, more than twice as long as most intervention studies conducted in community settings, which report the positive effects of interventions on physical activity adherence (Epstein et al, 1985, Elmer et al, 1995, Andersen et al, 1997, Dunn et al, 1998, Chau, 2009, Taggard et al, 2012,). Some of these studies have a follow-up period of up to 2 years, while most of them only have a follow-up of 6 months. As the health-related factors reported in this study had worsened or returned to a pre-intervention state since post-intervention, it emphasizes the importance of continuing guidance and personalized counselling when an intervention has seized so as to increase physical activity adherence. Interventions delivered by mail and telephone have shown great promise (Dunn et al, 1998, Heesch et al,2003, Evers et al, 2012), as they are both cost-effective and simple. An example of this is that a telephone-delivered motivational counselling once a month for 3 months delivered by a health professional enhances the adaptation of physical activity (Green et al, 2002). Interventions delivered by mail are also very effective and they seem to have an even greater effect on long-time adherence than telephone counselling (Marcus et al, 2007). The intervention in 2007 was very effective in increasing health and physical activity in short-term, but the long-term effect on health was little, if none. It would have been optimal to have continued some form of counselling to increase long-term adherence to physical activity and healthy eating habits. In our opinion this study clearly shows the importance of continued counselling to retain improvements in health obtained by the intervention.

This study shows that the health of Icelandic fishermen needs to be improved as many health related factors have worsened. The single least expensive and most efficient way of achieving improved health is by improve aerobic fitness through increased physical activity. A cost-efficient method for improving physical activity has been described elsewhere (Green et al, 2002, Marcus et al, 2007). Increasing physical activity and aerobic fitness has been shown to improve physical health by improving certain health related factors (Blair et al, 1986, Blair et al, 1996, Church et al, 2004, Haskell et al, 2009, McArdle et al, 2010, Barlow et al, 2012). Some of these are; decreasing high blood pressure, increasing HDL levels, lowering triglycerides levels, and improving heart and lung function (McArdle et al, 2010). Psychological well-being can also improve by increased physical activity and aerobic fitness, and health related factors such as depression, anxiety, mood and self-esteem have been noted to improve (Dunn et al, 2001, Hand et al, 2009, Olafsdottir et al, 2012). Quality of life comprises of factors, which are: physical, psychological, and social well-being. As physical activity and aerobic fitness improves, and the health related factors improve, quality of life usually improves (Steward, 1994, Olafsdottir, 2012). As the fishermen are at sea for weeks or months at a time, their possibility of physical exercise is limited. Employers can help improve physical activity of their employees by providing the opportunity and equipment for exercising, and encouraging them to maintain physical activity when employees are off-ship. Health-scientists can also be contacted to help increase employee physical activity and adherence. Employers will benefit as there is less employee absence from work and productivity increases (Burton et al, 2005).

This study also shows that sleep quality and length in Icelandic fishermen is lacking. This is consistent with other studies (Helgason et al, 1975, Ólafsdóttir, 2004, Ingvason, et al, 2005, Olafsdottir et al, 2012). Methods for improving sleep could require the employer to improve sleeping accommodations of the ships. Purchasing mattresses with memory foam have been shown to greatly improve spine curvature, and can greatly improve quality of sleep (Ólafsdóttir, 2004).

Another factor that greatly decreases quality of sleep and physical exercise is how short the fishermen are off-shift. On many ships the shift arrangement inhibits the chance of a long sleep and exercise as there is simply not enough time for the fishermen to nourish themselves, think about personal hygiene, exercise and sleep during the short span of time that they have off-shift. Employers are advised to rethink the shift arrangement, especially the length of shifts and off-shifts, so as to increase the opportunity of the fishermen to exercise and sleep when they are off-shift. This not only decreases the chance of injury and other health related ailments, but will also improve employee's job satisfaction, productivity and absenteeism (Wattles and Harris, 2003, Drake, et al, 2004).

5.4 Drop out and the healthy worker effect

Twenty-seven individuals dropped out between post-intervention and end of follow-up. A reason for this might be the healthy worker effect. As explained in chapter 1.1, the work of fishermen has long been regarded a harsh and hazardous occupation (Schilling, 1966, Lincoln et al, 2002). Therefore there might be a selection bias as to who chooses to become a fisherman: if an individual perceives himself as being physically healthy enough to work in a hazardous occupation, he is more likely to apply for work in one (Last, 1995, Checkoway et al, 2004). Also Individuals who are already employed in a harsh occupation but either don't perceive themselves as healthy anymore or sustain a long-term sickness are more likely to quit work (Thygesen et al, 2011).

The healthy worker effect might also apply to this study, as it is possible that the fishermen either decided not to participate in this study because of perceived bad health, or had quit their work.

6 Conclusion

The main findings of this study were that we observed worse conditions of health in Icelandic fishermen over a six year period. Moreover the positive effects of a physical activity and nutrition intervention initiated in 2007 had diminished six years later. The health related factors had either returned to their pre-intervention state or worsened. Interestingly, the reported quality of life among the fishermen had not changed. Finally, fishermen who received a physical activity and nutrition intervention in 2007 seem to have better health behaviour in retained physical activity, decreased smoking, and lower prevalence of obesity, six years later compared with their younger counterparts.

The first objective of this thesis was to explore the changes in a number of health related factors of Icelandic fishermen during a period of six years. The answer to this is that we observed a worsening of the conditions in a number of health related factors in Icelandic fishermen during six years of follow up. Positively physical activity had increased and smoking had decreased at the same time. During the same period QOL had not changed.

The second objective was to use data on a subgroup of the study, to investigate the effects of the previous lifestyle intervention study on physical activity adherence, and various health related factors at three time-points over a period of six years. The answer to the second objective is that the positive effect of the lifestyle intervention six years earlier had mostly diminished as conditions of the health related factors had either returned to their pre-intervention state or worsened. Physical activity had not changed between baseline and end of follow-up.

The third objective was to study whether there was a difference in health related factors between the intervention group and a pooled control group six years later. The answer to this is that there was no difference between these groups except in age and higher blood glucose in the intervention group. The participants in the intervention group were more physically active, had a lower prevalence of obesity and a relative lower prevalence of smoking, which might indicate better health literacy in this group.

The Last aim was to explore the changes in quality of life of Icelandic fishermen during a period of six years, and whether there was a difference between the intervention group and a pooled control group during this time. The answer to the last aim is that there was no change in quality of life in Icelandic fishermen during a period of six years. Also there were no differences between the intervention group and a pooled control group except in better self control in the intervention group. All the fishermen scored especially low in self control and sleep, with sleep being low at baseline and at end of follow-up, indicating a health risk in this occupation.

6.1 Future perspective

The single most cost-efficient way to improve overall health is to improve physical activity and aerobic fitness. Employers are urged to encourage employee physical activity to increase aerobic fitness, so as to increase overall health. Also employers will benefit greatly from providing the equipment for exercising when fishermen are on sea.

Employers also need to improve sleeping accommodations of the fishermen so as to ensure adequate sleep length and quality. The most cost-efficient way to improve sleep quality and length is to buy mattresses made out of memory foam. Rethinking the shift arrangement might also be an effective method for ensuring enough time for the fishermen to get physical activity and enough sleep, so as to maintain health.

Improving facilities for physical activity and sleep can greatly improve employees' job satisfaction, productivity and absenteeism.

This study was a follow-up study of a study made by Olafsdottir et al. In 2012 called "Lifestyle intervention at sea changes body composition, metabolic profile and fitness" involving some of Iceland's best scientists in physical activity and nutrition interventions.

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8 Appendix

8.1 Appendix 1: Article

The Health of Icelandic Fishermen; A six–year follow-up study

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Abstract:

Objectives: To explore the changes in a number of health-related factors of Icelandic fishermen over a period of six years. Furthermore to investigate the long-time effects of a previous lifestyle intervention on physical activity adherence, and various health-related variables.

Methods: Icelandic fishermen (n=77) participated in this study between December 2012 and March 2013, thereof 35 fishermen who participated in a previous study, that included an intervention for improved lifestyle, six years earlier. For comparison, baseline data from the intervention study was available for 62 fishermen. Height, weight, body mass index (BMI), waist circumference, estimates of body fat percentage (BF%) and blood pressure (BP) were measured. Blood lipids and blood glucose were measured. Aerobic fitness (W/kg) was measured with a maximal workload on a graded bicycle test and was then later converted into VO^2max. Smoking status, physical activity, diagnosed diabetes and blood lipid- and blood pressure medication use was obtained through questionnaires. Health related measurements were compared between different groups using ANCOVA or within-samples t-test when analysing the subgroup of the intervention study.

Results: Higher values in diastolic blood pressure, low-density lipoprotein total cholesterol and fasting glucose were measured among all fishermen in the year 2013 compared with six years earlier. Average aerobic fitness had decreased by 7% (*p*=.015) during the same time. Among the intervention group average weight and body mass index had increased by 3% (*p*=.05) and 3% (*p*=.047) respectively during a 6 year follow-up. Average aerobic fitness had decreased by 11% (*p*=.0002) in the intervention group. In 2013 self-reported physical activity was relatively higher (42% vs. 30%, p=.435), and smoking was relatively lower (17% vs. 26%, p=.400) in the intervention group compared to other fishermen. Also obesity was lower in the intervention group compared to other fishermen (17% vs. 32%, p=.046).

Conclusions: The health condition of fishermen worsened over a six year period. The fishermen who had received physical activity and nutrition intervention had mostly returned to their previous state or worsened six years later but had better health behaviour and lower prevalence of obesity compared with the pooled control group.

Introduction

Physical inactivity is connected to mortality, decreased health and well-being.[1-4] Moreover, physical inactivity is directly responsible for 5.5% to 6% of all deaths in the world, an estimated 1.9 million deaths per year.[1, 4] It is indirectly responsible for mortality caused by high blood pressure, high blood glucose and overweight and obesity, accounting for 13%, 6% and 5% of worldwide mortality respectively.[4] The global increase in inactivity related diseases and disabilities have also been seen in Iceland. In 2009 in Iceland the main cause of death was cardiovascular disease, then ischemic heart disease, then cerebrovascular disease and lastly cancers.[5]

The lifestyle of fishermen working on open-sea trawlers in Iceland is possibly degenerative to health. Long periods at sea, away from loved-ones not only diminishes the opportunities of physical activity, but also increases the chances of sleep-deprivation,[6, 7] Although open-sea trawler fishing can consist of hard physical work, with the mechanization of modern fishing ships it can be assumed that the occupational physical activity has decreased among fishermen over the past decades as observed among other physically demanding occupations.[7, 8] Furthermore, leisure time physical activity has been shown to decrease long-time sickness whereas occupational activity does not have the same effect.[8] Fishermen work in shifts which has been associated with decreased physical activity and many lifestyle related health problems.[9] It has been shown that fishermen are at more risk of work related stress than the general population and that the lack of physical exercise is one of the biggest stressors of working at sea.[9, 10]

Lifestyle interventions have been utilized to promote regular physical activity as a mean to solve the public health problems that result of inadequate physical activity or complete inactivity. Physical activity and nutrition interventions have been shown to effectively increase and maintain physical activity level.[11, 12] They usually have a follow-up period of up to four or five years, and show that positive effects of interventions can last years.[12] In our previous study we have demonstrated that a physical activity and diet intervention at sea improves health and fitness of Icelandic fishermen.[13] In this study physical activity was progressively increased, food patterns and health behaviours were changed over a 6 months period.

The first objective of the present study was to explore the changes in a number of health related factors of Icelandic fishermen during a period of six years.

Using data on a subgroup of the study, our second objective was to investigate the effects of the previous lifestyle intervention study on physical activity adherence, and various health related factors at three time-points over period of six years.

The third objective was to study whether there was a difference in health related factors between the intervention group and a pooled control group six years later.

Methods

Study design and population

Participants were fishermen working for the same fishing company on six different trawlers located around Iceland. Previously an intervention study was conducted in 2007 including sixty-two participants working for the same fishing company which has been described elsewhere.[13] All crew members and former participants in the 2007 study (in total 136) were invited to participate in the current study, (figure 1).

Between December 2012 and March 2013, seventy-seven (56.6% response rate) fishermen agreed to participate and gave their written informed consents. Thirty five individuals who participated in the intervention study in 2007 participated in the present study (56% response rate), thereof 24 men from the intervention group (all working on the same trawler, 77% response rate) and 11 men from the control group (working on the five other trawlers, 35% response rate). A total of 42 fishermen who had not previously participated agreed to participate.

The study protocol was approved by the Icelandic Ethical Review Board (VSNb2007030018/03.7).

Outcome Assessment

All outcome measurements were conducted at the laboratory and phlebotomy laboratory of the Icelandic Heart Association in Kopavogur, Iceland between December 2012 and March 2013.

Height was obtained using a wall-mounted stadiometer according to standard protocols.[14] Weight, body fat percentage and BMI were obtained using a Tanita TBF-310 body composition analyser (Tanita Corporation, Tokyo, Japan). Waist circumferences were measured as described by the WHO.[15]

A maximal cycle ergometer test (Ergoline GmbH, Ergoselect 100P, Bedieneinheim, Germany.) was performed by a doctor and master student with a computer (Cardioline, Prima Manager, version 6.17, protocol 50/25, San Diego, USA) to measure physical fitness (W/kg). To calculate the oxygen cost ($VO_2max = mL*kg^{-1}*min^{-1}$) the following equation from Golding et al. [16] was used:

$$VO2\,max = \left(\frac{Workload\ (W)}{Body\ mass\ (kg)} \times 10.8\right) + \ 3.5 + 3.5$$

Blood pressure was measured using a sphygmomanometer (Baumanometer, Wall Unit 33, type 0850, W. A. Baum Co. Inc.) according to standard protocols.[17]

After an overnight fast (≥10 hours) blood samples were obtained and analysed for serum total cholesterol, high-density lipoprotein, triglycerides and glucose. Low-density lipoprotein was then calculated by using the Friedewald et al. equation.[18]

Questionnaire

To obtain health-related quality of life, the Icelandic quality of Life questionnaire was administered to the fishermen. The Icelandic quality of life questionnaire has been validated for use in a research setting and consists of 32 questions regarding 12 subscales of quality of life.[19, 20]

Data on physical activity was obtained by a standard questionnaire administered by the Icelandic heart Association. Physical activity was defined as a conscious physical behaviour to improve health lasting for ≥1 hours per week. The same questionnaire asked questions regarding medication use, family history of diabetes, heart- and circulatory diseases, as well as smoking status.

Statistical analysis

All statistical analysis was conducted using SAS version 9.4 for windows (SAS Institute Inc., Cary, NC, USA).

When studying the changes in a number of various health related factors in fishermen, between 2007 and 2013 an Ancova test was performed. All variables were adjusted for age, physical activity, BMI and smoking status, as these have been reported to affect health related variables.[21-25] Moreover variables on aerobic fitness and blood pressure were additionally adjusted for blood pressure medication, and variables on blood lipids were additionally adjusted for blood lipid medication. To determine differences between categorical values within groups and between groups a Chi-squared test was performed.

The effects of the lifestyle intervention study on physical activity adherence on a subgroup of the present study (n=23) was also investigated, and various health related factors at three time-points using a within-samples t-test. Measurements made at baseline (in 2007) and at end of follow-up (in 2013) were compared, and measurements made at post intervention (in 2008) and at end of follow-up were compared. The intervention- and the control group were examined separately. One participant in the intervention group and one in the control group had incomplete data and were only used in the Ancova test.

Lastly, we explored whether there was a difference in health related factors between the intervention group and a pooled control group, during six years of follow-up using Ancova test. The pooled control group consisted of the 11 fishermen from the control group from the previous interventions and the 42 fishermen who had not previously participated. All variables were adjusted for age, physical activity, BMI, and smoking status. Moreover variables on aerobic fitness and blood pressure were additionally adjusted for blood pressure medication and variables on blood lipids were additionally adjusted for blood lipid medication. To determine differences between categorical values within groups and between groups a Chi-squared test was performed. P-values in analyses were two-sided.

Results

Physical characteristics of the Icelandic fishermen in 2013, and a comparison of various health related factors in fishermen between 2007 and 2013 can be seen in table 1.

When comparing health related factors of fishermen the measurement of aerobic fitness showed significantly higher values in 2007 compared with six years later, when adjusting for age, body mass index, physical activity and smoking status. However the number of individuals who reported being physically active (≥1 hours/week) was higher in 2013 (19% vs. 34%, p=.030), and there was a decline in individuals who smoke (≥1 cigarettes/day; 39% vs. 23%, p=.063). Diastolic blood pressure, total cholesterol, Low-density lipoprotein and fasting glucose were significantly higher in the fishermen in 2013 compared with the measurements in 2007. Quality of life was not significantly different between measurements.

<u>Intervention group</u>

Health related measurements were conducted three times during the study period for 23 men in the intervention group of the study (data of one participant was incomplete and was not used in this analysis). Table 2 shows data from the measurements at baseline, post-intervention and end of follow-up. Between post-intervention and end of follow-up a significant increase was observed in weight, body mass index, systolic blood pressure, diastolic blood pressure, body fat percentage, waist circumference, total cholesterol, low-density lipoprotein and fasting glucose. Aerobic fitness had significantly decreased by 14% during the 6 years after the intervention. Prevalence of overweight had not changed during the six years but prevalence of obesity had relatively increased from 13% to 17% (p=.811).

Reported physical activity had not changed between baseline and end of follow-up with 39% reporting being physically active. Smoking had relatively decreased between baseline and end of follow-up (26% vs. 17%, p=.722). Reported quality of life did not change during the same time period.

Control group

Health related measurements conducted three times during the study period were available for 10 participants in the control group (table 3). Between post-intervention to the end of follow-up a significant increase was observed in systolic blood pressure, diastolic blood pressure, body fat percentage, waist circumference and high-density lipoprotein.

Intervention group versus pooled control group in 2013

In table 4 a comparison of measurements between the intervention and the pooled control group in the year 2013 can be seen. The 11 fishermen in the previous control group and the 42 fishermen who had not previously participated were pooled into a combined control group, to increase the power of the statistical analysis, as there was no difference between the intervention group and the control group from 2007 (n=11).The pooled control group was then compared to the 24 fishermen who participated in the previous intervention and in this study.

The intervention group was older (4.5 years on average) and reported being more physically active than the pooled control group (42% vs. 30%, p=.058). Also the intervention group had a lower prevalence of obesity (17% vs. 32%, p=.046) and a relative lower prevalence of smoking (17% vs. 26%, p=.400) compared with the pooled control group. When adjusting for age, body mass index, physical activity and smoking status mean values for fasting blood glucose were significantly higher in the intervention group compared with the pooled control group, no other difference between the two groups was observed. No significant differences were found between the two control groups.

Discussion:

The main findings of this study were that we observed worsening conditions of health in Icelandic fishermen over a six year period. Moreover the positive effects of a physical activity and nutrition intervention initiated in 2007 had diminished six years later. The health related factors had either returned to their pre-intervention state or worsened. Interestingly, the reported quality of life among the fishermen had not changed. Finally, fishermen who received a physical activity and nutrition intervention in 2007 seem to have better health behaviour in retained physical activity and decreased smoking, and lower prevalence of obesity, six years later compared with their younger counterparts.

More Icelandic fishermen reported being physically active in 2013 compared with 2007 (34% vs. 19%), which is higher than what was reported in Europe in 2009.[26] It is likely that our participants were including work related physical activity in their self-assessment of physical activity. This would have led to an overestimation of their reported physical activity which was defined as a conscious physical behaviour to improve health lasting for ≥1 hours per week.

There was a borderline significant 25% fewer fishermen who smoked (≥1 cigarettes/day) in 2013 compared with fishermen in 2007. So it seems that the fishermen have improved their health literacy, which is associated with being a non-smoker.[27] Increases in physical activity have previously been linked with decreased smoking, showing a trend in improved health literacy with increased physical activity.[28, 29]

Aerobic fitness of all the Icelandic fishermen in 2013 was according to Golding et al. (1989),[16] on average 34 VO_2max $mL*kg^{-1}*min^{-1}$, which is poor for 40-49 year old males.[30] Aerobic fitness was not expected to decline to such an extent. As aerobic fitness was lower in 2013 compared with six years earlier it indicates that the fishermen were either not participating in activities that improve aerobic fitness or that they exaggerated their reported physical activity in 2013. Report failure and exaggeration has been reported in another study.[31] Possibly the exaggeration is due to the health education the fishermen in the intervention group received in 2007, and that due to their knowledge of the importance of physical activity they exaggerated their self-reported physical activity. Also smoking has been linked with decreased aerobic fitness,[32] and as physical activity was more prevalent and smoking was less prevalent in 2013 compared with six years earlier it would have been expected that aerobic fitness in 2013 was either higher or at least level with that reported six years earlier. It is of interest that their fitness is not much different from that of left ventricular contractile dysfunction patients.[33] Moreover, decreased VO_2max has been suggested as an early indicator of insulin resistance syndrome and type 2 diabetes and may be an important risk factor in the progression of these diseases.[34]

Blood pressure of the Icelandic fishermen was on average prehypertensive, according to current definitions.[35] The systolic blood pressure was especially high. This indicates a grave situation for the fishermen to be in, as clinically healthy disease-free adults, as prehypertension has an adverse cardiometabolic risk profile.[36] Possibly, if nothing is done, the situation will grow worse and the state of the participants could worsen to a life threatening state. Systolic hypertension is the most common form of hypertension and the global rate of diagnosis is rising rapidly.[37] It has been shown that a 10 mmHg rise in systolic blood pressure increases the risk of all fatal and non-fatal complications, except coronary events, by nearly 10%.[38]

The aerobic fitness of the participants in the intervention group in 2013 had on average statistically significantly decreased from the year 2008 even though participants reported no change in physical activity. According to Golding et al. (1989),[16] their VO_2max was 33 $mL*kg^{-1}*min^{-1}$ in 2013 which is below average for 40-49 year old males.[30]

The body mass index of the participants in the intervention group had increased, and their average value was classified as overweight.[39] Their average body fat percentage was high,[40] and had increased during follow-up. It seems that the increased body mass index score is not due to muscular increase but rather fat increase. This might further increase their health risk and decrease their ability to perform their work. Increased overweight among fishermen has been reported before,[41-43] indicating a general trend in this occupation that seems mostly to come from poor dietary habits and inactivity. Also, because of this lifestyle, fishermen have a higher risk of hospitalization due to lifestyle-related risks.[44] The trend of increased body mass index between 2007 and 2012 follows the general trend of Icelandic males.[45]

This study had a long follow-up period of 6 years, more than twice as long as most intervention studies conducted in community settings, which report the positive effects of interventions on physical activity adherence.[12, 46-50] Some of these studies have a follow-up period of up to 2 years, while most of them only have a follow-up of 6 months. As the health-related factors reported in this study had worsened or returned to a pre-intervention state since post-intervention, it emphasizes the importance of continuing guidance and personalized counselling when an intervention has seized so as to increase physical activity adherence. Interventions delivered by mail and telephone have shown great promise,[46, 51, 52] as they are both cost-effective and simple. An example of this is that a telephone-delivered motivational counselling once a month for 3 months delivered by a health professional enhances the adaptation of physical activity.[53] Interventions delivered by mail are also very effective and they seem to have an even greater effect on long-time adherence than telephone counselling.[54] The intervention in 2007 was very effective in increasing health and physical activity in short-term, but the long-term effect on health was little, if none. It would have been optimal to have continued some form of counselling to increase long-term adherence to physical activity and healthy eating habits. In our opinion this study clearly shows the importance of continued counselling to retain improvements in health obtained by the intervention.

Interestingly there was no statistical difference between the intervention group from 2007 and the fishermen that only participated at follow-up in 2013 (n=42) except in fasting glucose concentrations and blood pressure medications. We raised some questions to whether the effects might be more latent than believed. It is possible that the intervention from 2007 has had some protective effects against age-related decline in health which has been reported before. [55-59] The positive effects of physical activity on health are well known and thus it is possible that the health of the intervention group would have been worse at the end of follow-up if they had not participated in the intervention study.

Quality of life of all the fishermen is slightly over the norm reported in Icelandic males.[19] Quality of life has improved in individuals who are physically active,[60] even if they are pre-diagnosed with a disease.[61] It is possible that the physical activity and nutrition intervention in 2007 has had a protective effect on the quality of life of the fishermen, as their quality of life is not significantly different from post-intervention and has apparently not been affected to the same extent by age,[62-64] or working environment,[6, 10, 43] as reported in other studies. Happiness and well-being of Icelanders in general is high compared to other nations,[65, 66] which might further explain the high quality of life measured among Icelandic fishermen in the present study. In Iceland the average male has a higher quality of life than the average woman of the same age, and overall quality of life decreases with increased age although some aspects of quality of life improve with increasing age.[19]

Strength and weaknesses of this study:

This study is unique as no other study has studied the long-term effects of a physical activity and nutrition intervention on Icelandic fishermen and few international studies have such long follow-up for interventions. This study also included complete data for all health related variables as well as including two body composition measurements (percentage of body fat in addition to BMI), who in conjunction give us a more accurate measurements of the actual body fatness state of the participants. Also this study included an objective measurement of estimated aerobic fitness in W/kg which was later converted into VO_2max $mL*kg^{-1}*min^{-1}$ to better be able to compare aerobic fitness with other studies.

This study has some weaknesses. The recruitment of individuals in the control group was not ideal as only 11 individuals agreed to participation.

Information on the frequency of physical activity performed in leisure time was not objectively measured but was only obtained subjectively. This might lead to under- or overestimation of physical activity and skew the overall measurements of physical activity.

Blood pressure was only measured once after a 5 min. rest period. It is possible that the participants felt stressed when being measured, which has led to the high systolic blood pressure measured in this study. Measuring participants with high blood pressure on other days, so as to see whether the blood pressure would be lower might have worked against this problem.

Information about the nutritional habits of the participants was not gathered at the end of follow-up as in the intervention study. Gathering information about the nutritional state of the participants might have increased our knowledge of health behaviour and retention of healthy habits of Icelandic fishermen to this date.

In summary, our data shows worse conditions of health in Icelandic fishermen over a six year interval. For the intervention group the health related variables have worsened over a six year period. This further underlines the importance of continuing guidance and support after interventions to increase health benefits and adherence to physical activity in the long-term. Furthermore, six years later there was no overall difference in health related variables between the intervention group and fishermen in general (except in age, blood glucose and obesity rate) suggesting that the lifestyle of fishermen needs to be improved. It is possible that the intervention had a positive influence on the health literacy of the fishermen as fewer smoked and more were physically active at follow-up.

Tables

Table 1. Anthropometric measurements, blood values, blood pressure, physical fitness, prevalence of overweight and obesity, quality of life and various self-reported health related factors of Icelandic fishermen in 2007 and 2013

Variable	2007 (N=62)	2013 (N=77)[f]	% diff[β]	*P*-value
Age (years)	41.2 ± 1.2	44 ± 1.1	6.7	0.113[d]
Height (cm)	178.6 ± 0.8	180.1 ± 0.7	0.8	0.189[d]
Weight (kg)	88.8 ± 0.8	90.5 ± 0.7	1.9	0.141[d]
BMI (Kg/m^2)	27.2 ± 0.6	28.2 ± 0.5	3.6	0.243[d]
Waist circumference (cm)	97.8 ± 0.5	98.7 ± 0.4	0.9	0.285[d]
%BF	25 ± 0.3	25.6 ± 0.3	2.4	0.303[d]
SBP (mmHg)	123.7 ± 1.5	127.4 ± 1.3	2.9	0.087[d]
DBP (mmHg)	76.8 ± 1.0	80.7 ± 0.9	5	0.007[d]
HDL (mmol/L)[a]	1.42 ± 1.42	1.40 ± 1.40	1.4	0.762[d]
LDL (mmol/L)[a]	3.03 ± 0.11	3.51 ± 0.11	15.8	0.006[d]
Triglycerides (mmol/L)[a]	1.08 ± 1.08	1.02 ± 1.02	5.5	0.480[d]
Total Cholesterol (mmol/L)[a]	4.94 ± 0.11	5.38 ± 0.11	8.9	0.011[d]
Glucose (mmol/L)	5.12 ± 0.05	5.35 ± 0.05	4.4	0.005[d]
Aerobic fitness (W/kg)	2.7 ± 0.04	2.5 ± 0.03	7.4	0.015[d]
VO_2max (mL*kg^{-1}*min)	36.16 ± 7.43	34 ± 7.43	5.9	–
Overweight individuals (BMI ≥25 Kg/m^2), n (%)	45 (72.5)	64 (83.1)	42.2	0.150[e]
Obese individuals (BMI ≥30 Kg/m^2), n (%)	12 (19.3)	21 (27.2)	75	0.946[e]
	Self-reported data			
Individuals who are physically active (≥1 hrs./week), n (%)	12 (19.3)	26 (33.7)	116.6	0.030[e]
Individuals who smoke (≥1 cigarettes/day), n (%)	24 (38.7)	18 (23.3)	25	0.063[e]
Individuals with diagnosed diabetes, n (%)	1 (1.61)	1 (1.3)	–	1.000[e]
Individuals using blood lipid medication, n (%)	0 (0)	6 (7.7)	600	0.032[e]
Individuals using blood pressure medication, n (%)	5 (8)	15 (19.4)	200	0.087[e]
QOL (T-score)	51.3 ± 1.3	50.8 ± 0.9	0.9	0.783[d]

Variables Height through Aerobic fitness and QOL, are adjusted for age, physical activity, BMI and smoking status.
Numbers in Age through Aerobic fitness and QOL are means with SD.
Abbreviations; BMI, body mass index; %BF, body fat percentage; SBP, systolic blood pressure; DBP, diastolic blood pressure; HDL, high-density lipoprotein; LDL, low-density lipoprotein; QOL, quality of life.
VO^2max (mL*kg^{-1}*min) was calculated using the equation from Golding et al. (1989)[16]

[a] Adjusted for blood lipid medications.

[b] Adjusted for blood pressure medications.

[β] Percentage difference

[d] P-value determined by a ANCOVA test.

[e] P-value determined by a Chi-squared test.

[f] This number includes 23 fishermen that participated in the intervention group

Table 2. Anthropometric measurements, blood values, blood pressure, physical fitness, prevalence of overweight and obesity, quality of life and various self-reported health related factors in 2007, 2008 and in 2013 for the intervention group

Variable	2007 (n=23)	2008 (n=23)	2013 (n=23)	% change[β]	*P*-value[Ŧ]	% change[µ]	*P*-value[Ɣ]
Age (Years)	41.7	42 ± 10	47.1 ± 9.9	12.9	<.0001[a]	12.1	<.0001[a]
Height (cm)	180.1 ± 6.6	180.1 ± 6.8	179.9 ± 6.8	0.1	0.06[a]	0.1	0.096[a]
Weight (kg)	87.4 ± 10.1	86.3 ± 10	90.1 ± 12.8	3	0.05[a]	4.4	0.011[a]
BMI (Kg/m^2)	26.9 ± 2.6	26.5 ± 2.5	27.8 ± 3.1	3.3	0.047[a]	4.9	0.007[a]
Waist circumference (cm)	97.2 ± 7.3	96.8 ± 7.5	99.6 ± 9.5	2.4	0.068[a]	2.8	0.022[a]
%BF	24.6 ± 4.8	23.8 ± 4.6	26.8 ± 5.3	8.9	0.010[a]	12.6	.0003[a]
SBP (mmHg)	124 ± 13	122.4 ± 9.22	128.2 ± 11	3.3	0.047[a]	4.7	0.040[a]
DBP (mmHg)	76.8 ± 9.9	73.8 ± 6	83.3 ± 7.7	8.4	.0003[a]	12.8	<.0001[a]
HDL (mmol/L)	1.40 ± 0.28	1.51 ± 0. 38	1.40 ± 0.34	–	0.390[a]	7.2	0.615[a]
LDL (mmol/L)	3.09 ± 0.70	2.98 ± 0.78	3.53 ± 0.65	14.2	0.194[a]	18.4	0.002[a]
Triglycerides (mmol/L)	1.20 ± 0.38	0.99 ± 0.46	1.01 ± 0.44	15.8	0.001[a]	2	0.625[a]
Total Cholesterol (mmol/L)	5.05 ± 0.82	4.95 ± 0.74	5.4 ± 0.69	6.9	0.296[a]	9	0.003[a]
Glucose (mmol/L)[a]	5.09 ± 0.28	5.11 ± 0.5	5.46 ± 0.49	7.2	0.014[a]	6.8	0.006[a]
Aerobic fitness (W/kg)	2.7 ± 0.3	2.8 ± 0.4	2.4 ± 0.4	11.1	.0002[a]	14.2	<.0001[a]
VO_2max (mL*kg^{-1}*min)	36.1 ± 10.2	37.2 ± 11.3	32.9 ± 11.3	8.9	–	11.6	–
Overweight individuals (BMI ≥25 Kg/m^2) , n (%)	20 (86.9)	–	20 (86.9)	–	1.000[b]	–	–
Obese individuals (BMI ≥30 Kg/m^2) , n (%)	3 (13)	–	4 (17.3)	33.3	0.811[b]	–	–
		Self-reported data					
Individuals who are physically active (≥1 hrs./week), n (%)	9 (39.1)	–	9 (39.1)	–	1.000[b]	–	–
Individuals who smoke (≥1 cigarettes/day), n (%)	6 (26.1)	–	4 (17.3)	33.3	0.722[b]	–	–
Individuals with diagnosed diabetes, n (%)	0 (0)	–	0 (0)	–	1.000[b]	–	–
Individuals using blood lipid medication, n (%)	0 (0)	–	2 (8.7)	200	0.488 [b]	–	–
Individuals using blood pressure medication, n (%)	0 (0)	–	7 (30.4)	700	0.009 [b]	–	–
QOL (T-score)	49.7 ± 5.5	51.7 ± 4.7	52.05 ± 4.6	4.6	0.135[a]	0.5	0.590[a]

Numbers in Age through Aerobic fitness and QOL are means with SD.
2007, pre-intervention; 2008, post-intervention; 2013, follow-up.
Abbreviations; BMI, body mass index; %BF, body fat percentage; SBP, systolic blood pressure; DBP, diastolic blood pressure; HDL, high-density lipoprotein; LDL, low-density lipoprotein; QOL, quality of life.
VO^2max (mL*kg^{-1}*min) was calculated using the equation from Golding et al. (1989)[16]
[a] Differences between groups determined from within-samples t-test.
[b] P-values determined by a chi-squared test between the years 2007 and 2013
[β] Percentage change between 2007 and 2013
[µ] Percentage change between 2008 and 2013
[Ŧ] P-values indicate differences between 2007 and 2013
[Ɣ] P-values indicate differences between 2008 and 2013
Dashes indicate values that were not obtained at post-intervention.

Table 3. Anthropometric measurements, blood values, blood pressure, physical fitness, prevalence of overweight and obesity, quality of life and various self-reported health related factors in 2007, 2008 and in 2013 for the control group

Variable	2007 (n=10)	2008 (n=10)	2013 (n=10)	% change[β]	*P*-value[ŧ]	% change[µ]	*P*-value[ɣ]
Age (Years)	41.2 ± 5.6	41.7 ± 5.6	47.1 ± 5.5	14.3	<.0001[a]	12.9	<.0001[a]
Height (cm)	177.5 ± 6.5	178 ± 6.3	177.8 ± 6.3	0.16	0.131[a]	0.1	0.508[a]
Weight (kg)	82.1 ± 12.5	83 ± 13.4	84.9 ± 12.4	3.4	0.002[a]	2.2	0.097[a]
BMI (Kg/m^2)	26 ± 3.7	26.2 ± 4.1	26.8 ± 3.7	3	0.004[a]	2.2	0.093[a]
Waist circumference (cm)	92.5 ± 8	92.7 ± 8.8	96.6 ± 9.1	4.4	0.003[a]	4.2	0.012[a]
%BF	21.7 ± 6.2	21.9 ± 7	24.4 ± 6.9	12.4	.0001[a]	11.4	0.006[a]
SBP (mmHg)	118 ± 10.8	115.2 ± 11.2	121.6 ± 11	3	0.137[a]	5.5	0.029[a]
DBP (mmHg)	72.4 ± 9.6	73 ± 8.1	77.4 ± 8.3	6.9	0.071[a]	6	0.052[a]
HDL (mmol/L)	1.55 ± 0.28	1.40 ± 0.29	1.55 ± 0.24	-	0.986[a]	10.7	0.013[a]
LDL (mmol/L)	2.65 ± 0.72	3.22 ± 0.91	3.09 ± 0.81	16.6	0.005[a]	4	0.751[a]
Triglycerides (mmol/L)	0.91 ± 0.47	0.92 ± 0.31	0.82 ± 0.33	9.8	0.552[a]	10.8	0.948[a]
Total Cholesterol (mmol/L)	4.61 ± 67	5.05 ± 0.96	5.02 ± 0.83	8.8	0.029[a]	0.5	1.000[a]
Glucose (mmol/L)[a]	5.07 ± 0.41	4.88 ± 0.55	5.22 ± 0.31	2.9	0.188[a]	6.9	0.343[a]
Aerobic fitness (W/kg)	2.8 ± 0.3	2.8 ± 0.4	2.6 ± 0.3	7.1	0.014[a]	7.1	0.224[a]
VO_2max ($mL*kg^{-1}*min$)	37.2 ± 10.2	37.2 ± 11.3	35 ± 10.2	5.8	–	5.8	–
Overweight individuals (BMI ≥25 Kg/m^2) , n (%)	6 (60)	–	7 (70)	16.6	1.000[b]	–	–
Obese individuals (BMI ≥30 Kg/m^2) , n (%)	2 (20)	–	2 (20)	–	1.000[b]	–	–
		Self-reported data					
Individuals who are physically active (≥1 hrs./week), n (%)	1 (10)	–	3 (30)	200	0.582[b]	–	–
Individuals who smoke (≥1 cigarettes/day), n (%)	4 (40)	–	2 (20)	50	0.628[b]	–	–
Individuals with diagnosed diabetes, n (%)	1 (10)	–	1 (10)	–	1.000[b]	–	–
Individuals using blood lipid medication, n (%)	0 (0)	–	1 (10)	100	1.000[b]	–	–
Individuals using blood pressure medication, n (%)	1 (10)	–	0 (0)	100	1.000[b]	–	–
QOL (T-score)	54.8 ± 3.1	50 ± 5.6	54.4 ± 4.9	0.73	0.726[a]	8.8	0.169[a]

Numbers in Age through Aerobic fitness and QOL are means with SD.
2007, pre-intervention; 2008, post-intervention; 2013, follow-up.
Abbreviations; BMI, body mass index; %BF, body fat percentage; SBP, systolic blood pressure; DBP, diastolic blood pressure;
HDL, high-density lipoprotein; LDL, low-density lipoprotein; QOL, quality of life.
VO^2max ($mL*kg^{-1}*min$) was calculated using the equation from Golding et al. (1989)[16]
[a] Differences between groups determined from within-samples t-test.
[b] P-values determined by a chi-squared test between the years 2007 and 2013
[β] Percentage change between 2007 and 2013
[µ] Percentage change between 2008 and 2013
[ŧ] P-values indicate differences between 2007 and 2013
[ɣ] P-values indicate differences between 2008 and 2013
Dashes indicate values that were not obtained at post-intervention.

Table 4. Anthropometric measurements, blood values, blood pressure, physical fitness, prevalence of overweight and obesity, quality of life and various self-reported health related factors in 2013

Variable	Intervention group (n=24)	Pooled Control Group (n=53)	% diff.[β]	*P*-value
Age (years)	47.1 ± 1.8	42.6 ± 1.2	9.5	0.058[d]
Height (cm)	180.8 ± 1.2	179.5 ± 0.8	0.7	0.372[d]
Weight (kg)	92.6 ± 1.2	91.3 ± 0.8	1.4	0.380[d]
BMI (Kg/m^2)	27.9 ± 0.8	28.4 ± 0.5	1.7	0.718[d]
Waist (cm)	100.9 ± 0.8	99.3 ± 0.5	1.5	0.129[d]
%BF	27.2 ± 0.6	25.9 ± 0.4	4.7	0.114[d]
SBP (mmHg)	126.9 ± 2.5	128.8 ± 1.7	1.4	0.558[d]
DBP (mmHg)	81.9 ± 1.5	81.5 ± 1.0	0.4	0.837[d]
HDL (mmol/L)[a]	1.39 ± 0.09	1.40 ± 0.05	0.7	0.972[d]
LDL (mmol/L)[a]	3.51 ± 0.25	3.50 ± 0.15	0.2	0.954[d]
Triglycerides (mmol/L)[a]	1.01 ± 0.11	1.08 ± 0.06	6.9	0.650[d]
Total Cholesterol (mmol/L)[a]	5.34 ± 0.24	5.39 ± 0.15	1.4	0.963[d]
Glucose (mmol/L)	5.55 ± 0.11	5.28 ± 0.06	4.9	0.045[d]
Aerobic fitness (W/kg)	2.5 ± 0.07	2.5 ± 0.05	0	0.635[d]
VO_2max (mL*kg^{-1}*min)	34 ± 7.7	34 ± 7.5	0	–
Overweight individuals (BMI ≥25 Kg/m^2), n (%)	21 (87.5)	43 (81.1)	104.7	0.743[e]
Obese individuals (BMI ≥30 Kg/m^2), n (%)	4 (16.6)	17 (32)	325	0.046[e]
	Self-reported data			
Individuals who are physically active (≥1 hrs./week), n (%)	10 (41.6)	16 (30.1)	60	0.435[e]
Individuals who smoke (≥1 cigarettes/day), n (%)	4 (16.6)	14 (26.4)	240	0.400[e]
Individuals with diagnosed diabetes, n (%)	0 (0)	1 (1.8)	100	1.000[e]
Individuals using blood lipid medication, n (%)	2 (8.3)	4 (7.5)	100	1.000[e]
Individuals using blood pressure medication, n (%)	8 (33.3)	7 (13.2)	12.5	0.060[e]
QOL (T-score)	51.9 ± 1.7	50.5 ± 1.2	2.6	0.516[d]

Variables Height through Aerobic fitness and QOL, are adjusted for age, physical activity, BMI and smoking status.
Numbers in Age through Aerobic fitness and QOL are means with SD.
Abbreviations; BMI, body mass index; %BF, body fat percentage; SBP, systolic blood pressure; DBP, diastolic blood pressure; HDL, high-density lipoprotein; LDL, low-density lipoprotein; QOL, quality of life.
VO^2max (mL*kg^{-1}*min) was calculated using the equation from Golding et al. (1989)[16]
[a] Adjusted for blood lipid medications.
[b] Adjusted for blood pressure medications.
[β] Differences in percentages
[d] P-value determined by a ANCOVA test.
[e] P-value determined by a Chi-squared test.

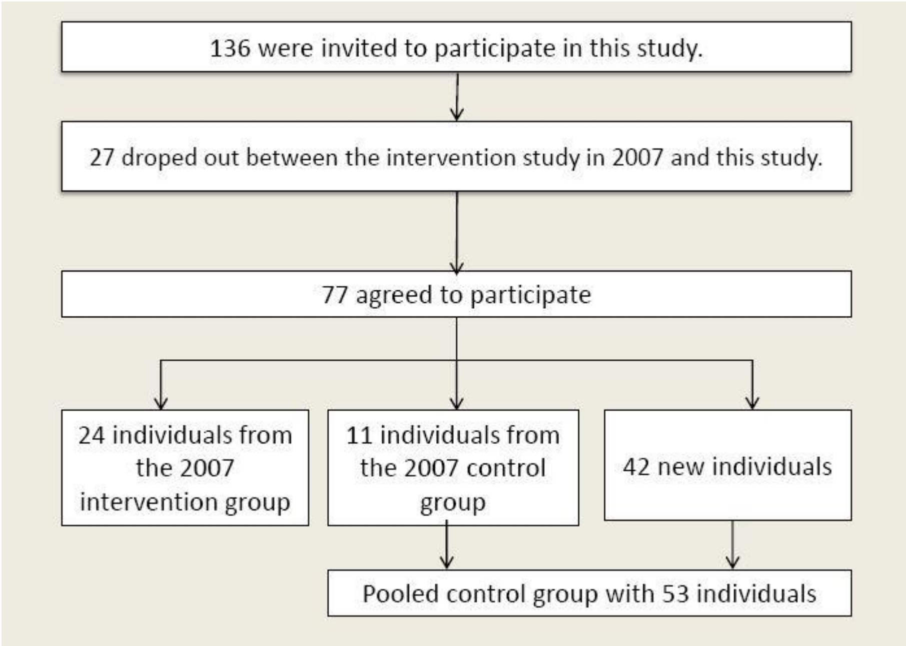

Figure 1. Flow-chart of participation

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8.2 Appendix 2: Approval of the Icelandic Ethical Committee

VÍSINDASIÐANEFND

Hafnarhúsið, Tryggvagata 17
101 Reykjavík,

Sími: 551 7100, Bréfsími: 551 1444

netfang: visindasidanefnd@vsn.stjr.is

Kennaraháskóli Íslands, Íþróttafræðasetur,
Laugarvatni
Erlingur Jóhannsson
Kennaraháskóli Íslands, Íþróttafræðasetur,
Laugarvatni
840 Laugarvatn
Ísland

Reykjavík 20. nóvember 2012
Tilv.: VSNb2007030018/03.7

Efni: 07-052-V1 Heilsufar sjómanna.

Á fundi sínum 20.11.2012 fjallaði Vísindasiðanefnd um umsókn þína dags. 13.11.2012, vegna viðbótar við ofangreinda rannsóknaráætlun. Í erindinu kemur fram að rannsakendur óska nú eftir því að fá heimild til að gera viðbótarmælingar á sama rannsóknarþýði og gert var 2007. Öllum sjómönnum á fjórum fiskiskipum Brims ehf verður boðin þátttaka en allir þátttakendurnir 2007 voru á þessum skipum. Brim ehf hefur veitt formlegt leyfi eins og þeir gerðu 2007 og þeir greiða einnig allan kostnað við mælingar eins og 2007.
Allar mælingar verða gerðar á sama hátt og 2007 en þær byggjast fyrst og fremst á áhættumati Hjartaverndar en rannsóknin er framkvæmd í samstarfi við Rannsóknarstofu Hjartaverndar. Þessar viðbótarmælingar eru meistaraprófsverkefni Eliths Freys Heimissonar.

Nýtt bréf með upplýsingum og samþykkisbréfi fyrir þátttakendur fylgdi sem fylgiskjal og einnig endurbættur spurningalisti en spurningar frá 12 til og með 21 eru nýjar.

Vísindasiðanefnd hefur farið yfir bréf þitt og gerir ekki athugasemdir við tilgreindar breytingar. Viðbót nr. 1 ásamt fylgigögnum við ofangreinda rannsókn, er endanlega samþykkt af Vísindasiðanefnd.

Ítrekað er að ábyrgðarmanni ber að láta stofnanir, sem áður hafa veitt leyfi vegna framkvæmdar rannsóknarinnar, vita af ofangreindri breytingu á rannsóknaráætluninni.

Með kveðju,
f.h. Vísindasiðanefndar,

dr. med., Björn Rúnar Lúðvíksson, læknir, formaður

8.3 Appendix 3: Approval of BRIM Seafood

BRIM SEAFOOD

Brim hf.
Bræðraborgarstígur 16
101 Reykjavík
Iceland

Tel. +354 580 42 00
Fax +354 580 42 01

www.brimseafood.is

Vísindasiðanefnd
Hafnarhúsinu,
Tryggvagötu 17
101 Reykjavík

Reykjavík 12. nóvember 2012

Efni: Rannsóknarverkefnið, Heilsa Sjómanna – 2012

Forráðmenn Brim hf eru samþykkir því að sjómenn á fiskiskipunum Guðmundur í Nesi, Brimnes, Kleifaberg og Sólberg verði boðin þátttaka í rannsóknarverkefninu Heilsa sjómanna - 2012. Verkefnið er framhaldsrannsókn sem framkvæmd var hjá fyrirtækinu 2007 (Heilsa sjómanna – 2007).

Virðingarfyllst,

Karl Már Einarsson

Karl Már Einarsson,
útgerðarstjóri

8.4 Appendix 4: Approval of the Icelandic Heart Association

13.11.2012

Vísindasiðanefnd
Hafnarhúsinu,
Tryggvagötu 17
101 Reykjavík

Varðar rannsókn á vegum Erlings Jóhannssonar prófessors Menntasviði Háskóla Íslands: Heilsa Sjómanna - 2012.

Það staðfestist hér með að Hjartarannsókn mun sinna áhættumati hjarta- og æðasjúkdóma ásamt áreynsluprófi á sjómönnum sem starfa hjá Brimi hf vegna rannsóknarinnar Heilsa sjómanna 2012. Niðurstöðum verður safnað í gagnagrunn og afhent Erlingi Jóhannessyni verkefnisstjóra rannsóknarinnar enda hafi allir þátttakendur skrifað undir upplýst samþykki fyrir því.

Virðingarfyllst

Bolli Þórsson, læknir Hjartarannsóknar

8.5 Appendix 5: Informed consent

Upplýsingar
um rannsóknina

Heilsa sjómanna – 2012

Kæri viðtakandi Desember, 2012

Heilsufarsvandamál sem tengjast lifnaðarháttum fólks hafa aukist til mikilla muna á undanförnum árum. Gott heilsufar einstaklinga er allra hagur, ekki eingöngu fyrir einstaklinginn sjálfan heldur einnig fyrir samfélagið þar sem lífstílssjúkdómar eru mjög kostnaðarsamir.

Ábyrgðarmaður rannsóknarinnar er dr. Erlingur Jóhannsson, prófessor við Háskóla Íslands, netfang: erljo@hi.is, sími: 897-1115. Rannsóknin er meistaraprófsverkefni Eliths Freys Heimissonar en unnin í samstarfi við Hjartavernd.

Markmið rannsóknarverkefnisins er að kanna heilsu og líkamsástand þeirra sjómanna sem tóku þátt í rannsókninni „Heilsa sjómanna – 2007". Þátttakendur mæta einu sinni í Hjartavernd og fara þar í hefðbundið áhættumat sem innifelur mælingar á blóðþrýstingi, þyngd, fituhlutfalli, mittismáli, hjartalínurit, þrekpróf og blóðrannsóknir. Einnig verður lagður fyrir þá spurningarlisti um heilsu.

Ef þú ert reiðubúinn til að taka þátt í rannsókninni biðjum við þig að kynna þér fyrirkomulag hennar og fylla út meðfylgjandi samþykkisyfirlýsingu. Þátttaka þín í þessari rannsókn er mjög mikilvæg en nafn þitt mun hvergi koma fram, hvorki við úrvinnslu né birtingu niðurstaðna. Farið verður með allar upplýsingar sem trúnaðarmál.

Hafir þú spurningar um rétt þinn sem þátttakandi í vísindarannsókn eða vilt hætta þátttöku í rannsókninni getur þú snúið þér til Vísindasiðanefndar, Hafnarhúsinu, Tryggvagötu 17, 101 Reykjavík, sími 551-7100, fax 551-144, tölvupóstfang: visindasidanefnd@vsn.stjr.is.

Með þökk og kærri kveðju,

____

Dr. Erlingur Jóhannsson, prófessor Háskóla Íslands.
Sími: 897-1115. Netfang: erljo@hi.is

____

Eliths Freyr Heimisson, meistaranemi Háskóla Íslands.
Sími: 867-2353. Netfang: heimirsson86@gmail.com

Verkþættir rannsóknarinnar
Heilsa sjómanna - 2012

Þátttaka í rannsókninni felst í eftirfarandi þáttum:

1. Á tímabilinu 1. desember 2012 til 15. febrúar 2013 verða þátttakendur boðaðir í áhættumat í Hjartavernd. Auk þeirra atriða sem mæld verða í áhættumati verður mæld hæð, þykkt við húðmælingu á fjórum stöðum á líkamanum auk mælingar á ummáli upphandleggs, mittis og mjaðma. Einnig verður í lokin lagður fyrir spurningalista. **Mjög mikilvægt er að láta Eliths (s: 857-2353) vita ef viðkomandi kemst alls ekki á fyrirframákveðnum tíma**.
   Mæting er í Hjartavernd, Holtasmára 1, 200 Kópavogi.
2. Fagteymi Hjartaverndar mun lesa og túlka niðurstöður og þátttakendum verður ráðlagt eftir þeim niðurstöðum.

Samþykkisyfirlýsing
um þátttöku í rannsókninni
Heilsa sjómanna - 2012

Ég hef kynnt mér alla verkþætti rannsóknarinnar og samþykki að taka þátt í öllum þáttum rannsóknarinnar.

Dags.:_________________ Nafn:___________________________________

Með þökk og kærri kveðju,

____

Dr. Erlingur Jóhannsson, prófessor Háskóla Íslands.
Sími: 897-1115. Netfang: erljo@hi.is

____

Eliths Freyr Heimisson, meistaranemi Háskóla Íslands.
Sími: 857-2353. Netfang: heimirsson86@gmail.com

8.6 Appendix 6: Icelandic Quality of Life (IQL)

Heilsa sjómanna - 2012

Ágæti þátttakandi

Rannsóknin „Heilsa sjómanna - 2012“ er meistaraprófsverkefni Eliths Freys Heimissonar í íþrótta- og heilsufræði við Háskóla Íslands. Meginmarkmið rannsóknarinnar er að skoða heilsutengda þætti sjómanna sem starfa hjá Brim árið 2012. Þátttakendur verða þeir sömu og tóku þátt í rannsókninni „Heilsa sjómanna - 2007“ sem framkvæmd var haustið 2007 en sú rannsókn var meistaraprófsverkefni Sonju Sifjar Jóhannsdóttur.

Þátttaka í rannsóknini er frjáls en miklu máli skiptir að sem flestir takið þátt. Spurningarlistinn er staðlaður og svara allir einstaklingar sömu spurningum. Til að svara einstökum spurningum getur verið erfitt að velja aðeins einn svarkost og stundum á ekkert svar nákvæmlega við um þig en þá ert þú beðin(n) að velja það svar sem best á við. Við biðjum þig að svara öllum spurningum eftir bestu getu en þú getur sleppt þeim spurningum sem þú treystir þér alls ekki til að svara.

Þegar búið er að svara spuringarlistanum verður hann innsiglaður í trúnaðarumslög. Einginn annar en höfundur mun koma að úrvinnslu spurningarlistans. Þegar lesið hefur verið úr spurningarlistanum verður honum eytt. Erlingur Jóhannson prófessor við Háskóla Íslands er stjórnandi rannsóknarinnar og ber ábyrgð á framkvæmd hennar. Hann veitir allar frekari upplýsingar í síma 897 1115 eða með tölvupósti erljo@hi.is.

Kærar þakkir fyrir þátttökuna,

Erlingur S. Jóhannsson, Eliths Freyr Heimisson og Sonja Sif Jóhannsdóttir

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HEILSUTENGD LÍFSGÆÐI

Við mat á árangri meðferðar skiptir mestu máli hvernig sjúklingum líður áður en hún hefst og hvort meðferðin hefur bætt það sem kalla má heilsutengd lífsgæði. Þau getur enginn metið betur en einstaklingurinn sjálfur. Svo að unnt sé að meta árangur meðferðarinnar er nauðsynlegt að hafa sambærileg gögn í sjúkraskrá. Því biðjum við þig að svara eftirfarandi spurningum núna með því að dekkja hringina með blýanti eða skrifa á línurnar, eftir því sem við á hverju sinni. Mikilvægt er að öllum spurningum sé svarað.

Aldur: ________ ára

0	O	O
1	O	O
2	O	O
3	O	O
4	O	O
5	O	O
6	O	O
7	O	O
8	O	O
9	O	O

Kyn:
- O karl
- O kona

1. Þegar á heildina er litið, finnst þér heilsa þín vera:

- O slæm
- O þokkaleg
- O góð
- O mjög góð
- O framúrskarandi

2. Varstu með verki síðastliðnar fjórar vikur og ef svo var, hve mikla verki?

- O mjög mikla
- O mikla
- O þó nokkra
- O litla
- O mjög litla
- O enga

3. Að hve miklu leyti hefur andleg eða líkamleg heilsa þín takmarkað félagslega umgengni þína við fjölskyldu, vini, nágranna eða aðra hópa, síðustu fjórar vikurnar?

- O mjög mikið
- O töluvert
- O þó nokkuð
- O svolítið
- O alls ekkert

4. Hversu hress og fjörmikil(l) hefur þú verið? (*síðastliðinn mánuð*)

- O alveg kraftlaus og uppgefin(n), öll orka búin
- O mjög þróttlítil(l) og dauf(ur) flestum stundum
- O yfirleitt frekar þróttlítil(l) og dauf(ur)
- O krafturinn í mér hefur sveiflast töluvert
- O oftast nokkuð hress og kraftmikil(l)
- O mjög hress - full(ur) orku

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5. Hversu gleymin(n) hefur þú verið? *(síðastliðinn mánuð)*

- O mjög mikið
- O töluvert
- O þó nokkuð
- O svolítið
- O alls ekkert

6. Ég hef verið niðurdregin(n) og leið(ur) *(síðastliðinn mánuð)*

- O alltaf
- O yfirleitt
- O talsvert oft
- O stundum
- O einstöku sinnum
- O aldrei

7. Hefur þú verið svo hrygg(ur), kjarklítil(l), vonlaus, eða haft svo mörg vandamál á þinni könnu að þú hafir velt fyrir þér hvort allt væri tilgangslaust? *(síðastliðinn mánuð)*

- O afskaplega, ég hef verið að gefast upp
- O mjög
- O þó nokkuð
- O dálítið, nóg til að trufla mig
- O örlítið
- O alls ekki

8. Hefur þér fundist þú vera virk(ur) og þróttmikil(l) eða dauf(ur) og svifasein(n)? *(síðastliðinn mánuð)*

- O mjög dauf(ur) og svifasein(n) alla daga
- O yfirleitt dauf(ur) og svifasein(n)
- O frekar dauf(ur) og svifasein(n)
- O frekar virk(ur) og þróttmikil(l)
- O yfirleitt virk(ur) og þróttmikil(l)
- O mjög virk(ur) og þróttmikil(l) alla daga

9. Hefur þú verið afslöppuð/afslappaður og rólegur *eða* trekkt(ur), spennt(ur) og eins og fest(ur) upp á þráð? *(síðastliðinn mánuð)*

- O verið trekkt(ur), spennt(ur) og eins og fest(ur) upp á þráð allan mánuðinn
- O oftast nær verið trekkt(ur), spennnt(ur) og eins og fest(ur) upp á þráð
- O yfirleitt trekkt(ur) en hef stundum getað slappað af
- O yfirleitt afslöppuð/afslappaður en stundum dálítið trekkt(ur)
- O oftast nær verið afslöppuð/afslappaður og róleg(ur)
- O verið afslöppuð/afslappaður og róleg(ur) allan mánuðinn

10. Hefur þú verið kvíðin(n), áhyggjufull(ur) eða í geðshræringu? *(síðastliðinn mánuð)*

- O afskaplega - upp að því marki að vera veik(ur), eða nærri því
- O mjög svo
- O þó nokkuð
- O svolítið - nóg til að angra mig
- O dálítið
- O alls ekkert

11. Ég hef verið í tilfinningalegu jafnvægi og örugg(ur) með mig *(síðastliðinn mánuð)*

- O aldrei
- O einstöku sinnum
- O stundum
- O talsvert oft
- O yfirleitt
- O alltaf

12. Hvernig metur þú heilsufar þitt?

- O slæmt
- O sæmilegt
- O gott
- O mjög gott
- O gæti ekki verið betra

13. Kemur heilsa þín í veg fyrir að þú getir sinnt vinnu þinni, skóla eða heimilisstörfum?

- O já, og hefur gert það í meira en 3 mánuði
- O já, og hefur gert það í 3 mánuði eða styttri tíma
- O nei

14. Setur heilsan þér einhver takmörk núna við að vinna miðlungi erfið verk, t.d. færa til húsgögn, ryksoga eða bera matvælapoka inn eftir verslunarferð?

- O já, háir mér mikið
- O já, háir mér svolítið
- O nei, háir mér ekkert

15. Heilsa mín er mjög góð

- O örugglega rangt
- O að mestu rangt
- O veit ekki
- O að mestu rétt
- O örugglega rétt

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16. Hve langan tíma síðustu fjórar vikur fannst þér þú vera full(ur) af lífsþrótti?

- aldrei
- lítinn hluta tímans
- nokkurn hluta tímans
- drjúgan hluta tímans
- meiri hluta tímans
- allan tímann

17. Hve langan tíma síðustu fjórar vikur hafðir þú næga orku?

- aldrei
- lítinn hluta tímans
- nokkurn hluta tímans
- drjúgan hluta tímans
- meiri hluta tímans
- allan tímann

18. Hve langan tíma síðustu fjórar vikur hefur þú verið niðurdregin(n) og leið(ur)?

- allan tímann
- meiri hluta tímans
- drjúgan hluta tímans
- nokkurn hluta tímans
- lítinn hluta tímans
- aldrei

19. Hve langan tíma síðustu fjórar vikur hefur þú verið vonlaus um framtíðina?

- allan tímann
- meiri hluta tímans
- drjúgan hluta tímans
- nokkurn hluta tímans
- lítinn hluta tímans
- aldrei

Merktu við það svar sem þér finnst eiga best við þig.

Hafðir þú óþægindi síðastliðna viku að meðtöldum deginum í dag vegna þess að þú:

20.	varst döpur (dapur)	alltaf O	oft O	stundum O	sjaldan O	aldrei O
21.	áttir erfitt með að sofna	alltaf O	oft O	stundum O	sjaldan O	aldrei O
22.	áttir erfitt með að einbeita þér	alltaf O	oft O	stundum O	sjaldan O	aldrei O

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Dekktu þann hring sem lýsir því best hvernig viðkomandi fullyrðing á við um þig síðastliðna viku að meðtöldum deginum í dag.

23. Líkamleg líðan mín er: ○ ○ ○ ○ ○ slæm — góð

24. Mér finnst ég hafa stjórn á lífi mínu ○ ○ ○ ○ ○ slæma — góða

25. Ég get látið enda ná saman ○ ○ ○ ○ ○ illa — vel

26. Ég hef áhyggjur af fjárhag mínum ○ ○ ○ ○ ○ miklar — litlar

27. Ég sef ○ ○ ○ ○ ○ illa — vel

Vinsamlega svaraðu spurningum 28 - 32 með því að merkja við eina tölu á hverjum kvarða. Leggðu mat þitt á skalann frá: 1= mjög óánægður til 10= hæst ánægður

28. Ertu ánægð(ur) með líf þitt eins og það er í dag?

○ ○ ○ ○ ○ ○ ○ ○ ○ ○
1 2 3 4 5 6 7 8 9 10
mjög óánægð(ur) — hæst ánægð(ur)

29. Ertu ánægð(ur) með heilsu þína eins og hún er í dag?

○ ○ ○ ○ ○ ○ ○ ○ ○ ○
1 2 3 4 5 6 7 8 9 10
mjög óánægð(ur) — hæst ánægð(ur)

30. Ertu ánægð(ur) með félagslega stöðu þína eins og hún er í dag?

○ ○ ○ ○ ○ ○ ○ ○ ○ ○
1 2 3 4 5 6 7 8 9 10
mjög óánægð(ur) — hæst ánægð(ur)

31. Ertu ánægð(ur) með frístundir þínar eins og þær eru í dag?

○ ○ ○ ○ ○ ○ ○ ○ ○ ○
1 2 3 4 5 6 7 8 9 10
mjög óánægð(ur) — hæst ánægð(ur)

32. Hvernig líður þér í dag?

○ ○ ○ ○ ○ ○ ○ ○ ○ ○
1 2 3 4 5 6 7 8 9 10
mjög illa — mjög vel