Cost-effectiveness of the promotion of physical activity in health care

Lars Hagberg

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Abstract

Introduction
Physical inactivity is a major cause of reduced quality of life, as well as many common diseases and even premature death. Most people, globally, are scarcely or rarely physically active. Consequently, physical inactivity influences the burden of disease, and increases its societal costs. In view of this, it is necessary to ask how health care should respond when the population and the patients are either inactive or rarely physically active. Cost-effectiveness analyses of the promotion of physical activity in health care can contribute substantially to health care policy.

Aims
The overall aim of this thesis was to investigate the cost-effectiveness of physical activity promotion in the health care system. The specific aims were: (I) to provide a model for analyzing cost-effectiveness and equity in health for community-promoted physical activity, (II) to review current knowledge about the cost-effectiveness of health care based interventions aimed at improving physical activity, (III) to evaluate the cost-effectiveness of physical activity promotion as a treatment method in primary health care, (IV) to illustrate the importance of enjoyment of exercise in interventions aimed at promoting physical activity, and (V) to describe a method of valuing the time spent on exercise.

Methods
Standard methods for economic evaluation were studied and adapted to create a model for the evaluation of physical activity promotion (I). Relevant databases were searched for published articles, and the articles found were analyzed using this economic evaluation model (II). A trial in primary health care was evaluated in a cost-utility analysis based on the model (III). In the same trial, the association between time spent on exercise and enjoyment of exercise was analyzed (IV). A model for valuing the time spent on exercise was developed and used. Time costs were significantly higher among inexperienced exercisers (V).

Results
An economic evaluation model was developed, as was a model to calculate an intervention’s effect on equity in health (I). In total, 26 articles were found regarding the cost-effectiveness of physical activity promotion in health care, and 20 of these described interventions, which the authors considered to be cost-effective (II). The treatment of patients in primary health care by the promotion of physical activity was shown to be cost-effective (III). For the same group of patients, time spent on exercise was associated with enjoyment of exercise (IV). A model for valuing the time spent on exercise was developed and used. Time costs were significantly higher among inexperienced exercisers (V).

Conclusions
There are many examples of interventions promoting physical activity that may be regarded as cost-effective. In general, it seems to be cost-effective to promote physical activity among patients...
with increased risk, or who manifest poor health associated with physical inactivity. Unfortunately, there is still little evidence of when physical activity should be used, or what the best design of such an intervention might be.

Although there is still a need for stronger evidence, the Swedish health care system should use the promotion of physical activity as a standard method among the following patients:

- those who manifest increased risk (such as high blood pressure) of ill health due to a physically inactive lifestyle;
- frail older people, especially those with increased risk of fall injuries;
- those requiring rehabilitation after heart failure.

**Key words:** physical activity promotion, cost-effectiveness, health care
Preface

Most people know that physical activity is good for their health, but despite that are many too little physically active. A great many resources in health care are used to treat health problems related to living conditions and lifestyle, of which physical inactivity is a significant part [1]. The health care system understands how to use drugs to reduce both pain and the risk for serious events caused by sedentary lifestyle, but methods to promote physical activity are less well known. Hence, an understanding of methods for promoting physical activity is of great importance both for the future health of the nation and health care costs. The report from the U.S. Department of Health and Human Services – "Physical Activity and Health; A Report from the Surgeon General" [2] states

"The effort to understand how to promote more active lifestyles is of great importance to the health of this nation. Although the study of physical activity determinants and interventions is at an early stage, effective programs to increase physical activity have been carried out in a variety of settings, such as schools, physicians’ offices, and worksites. Determining the most effective and cost-effective intervention approaches is a challenge of the future.”

The promotion of physical activity can be approached from a number of different points of view. In this thesis, a societal perspective is used. The outcome will be of interest to society as a whole and not only for the health care professional. The public health is of interest, but the arena of physical activity promotion is that of the health care system. Most of the research regarding the promotion of physical activity is realized in an international environment, with the USA being the leading country. For the most part, this thesis is based on research conducted in international settings, but the discussion, in particular regarding priorities for the health care, is with regard to the Swedish health care system.
List of papers

This thesis is based on the following papers:


III. Hagberg, Nyberg, Hellénius & Lindholm Cost-effectiveness analysis of the promotion of physical activity as a treatment method in primary health care. Manus

IV. Hagberg, Lindahl, Nyberg & Hellénius The importance of enjoyment of exercise in promoting physical activity. Manus

V. Hagberg & Lindholm Time costs of exercise in interventions aimed at promoting physical activity. Manus

The economic analysis model (paper I) is the foundation of the thesis. The model is used as a basis for both the review article (paper II) and in the evaluation of a primary health care trial (paper III). The discussion from the review article has been important as a reference in paper III. Paper IV describes how the enjoyment of exercise is an important factor for the effectiveness of the intervention. In the economic analysis model, the cost of time is identified as having a major impact on cost-effectiveness. A model for estimating the cost of time spent on exercise has been developed in paper V. The relationships between the papers are expressed in Figure 1.

![Figure 1: Papers in the thesis and their connection](image_url)

Papers I and II are reprinted with permission from the publishers.
Glossary

This glossary is mainly derived from Public Health Dictionary [3], when not other sources are mentioned.

**Adherence** The participants’ time given to the program. In this thesis, adherence is the time spent on physical activity due to an intervention with physical activity promotion.

**Bias** Every influence on the study that leads to a deviation of the results from the real conditions. There are several types of bias, including design bias, gender bias, instrument bias, observation bias and publication bias.

**Cost-effectiveness** The relation between costs and health gains. In The National Board of Health and Welfare guidelines is a statement of cost-effectiveness ratios. Less than 100,000 SKr per gained QALY (quality adjusted life years) is regarded as low costs in relation to health benefits, 100,000-500,000 SKr as moderate, 500,000-1,000,000 SKr as high, and above 1,000,000 SKr as very high costs in relation to health benefits.

**Effectiveness** The extent to which a specific intervention, procedure, regimen, or service, when deployed in the field, does what it is intended to do for a targeted population. When promoting physical activity, it is a result of efficacy of physical activity, adherence and population penetration.

**Efficacy** Effectiveness under ideal conditions.

**Enjoyment of exercise** Enjoyment may be described as an affective state of positive feelings, such as pleasure, liking, and fun [4, 5]. In this thesis, enjoyment of exercise is defined as the arising emotions that participants experienced during exercise. The definition may also cover aspects such as relaxation and pain reduction.

**Equity in health** The condition that everybody has a fair possibility to reach his potential of health, or more pragmatic expressed, nobody is unfairly treated in this aim.

**Exercise** A part of physical activity and the term is often used to describe activities with a certain aim; to gain health, enjoyment etc. Exercise is usually performed in sessions, for instance a walk, resistant training or a football match.

**Evidence based medicine** The conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence-based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research [6].

**Health** There are a lot of definitions of health and no consensus of measurement methods. Health is not necessary the opposite of illness. This is emphasized in the WHO definition; ”Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” [7].

**Informal care** A nonmarket composite commodity consisting of heterogeneous parts produced (paid or unpaid) by one or more members of the social environment of the care recipient as a result of the care demands of the care recipient [8].
Marginal cost The increase of the gross costs when producing one more unit of a product.

Mediator An intervening causal variable that are necessary for creating a cause-effect pathway between different interventions and physical activity [9].

Opportunity cost The cost of passing up the next best choice when making a decision. For example, if an asset such as capital or time is used for one purpose, the opportunity cost is the value of the next best purpose the asset could have been used for.

Physical activity Bodily movements that are produced by the contraction of skeletal muscle accompanied by a substantial increase in energy expenditure [10].

Population penetration Refers to a program's capacity to recruit participants from the whole target group and can be expressed as the proportion of those invited that participate in the program during a specified time period [11].

Prevention Efforts to prevent ill health. Primary prevention is an active assertive process of creating conditions and or personal attributes that promotes the well-being of people. Secondary prevention is early detection and intervention to keep beginning problems from becoming more severe. Tertiary prevention is the effort to rehabilitate those affected with severe disorders.

Promotion Efforts to promote a certain thing. In this thesis it is used for promoting health, usually by promoting physical activity with aim of health gains.

QALY Quality adjusted life year, a year of life adjusted for its quality or its value. A year in perfect health is considered equal to 1.0 QALY.

Randomized controlled trial (RCT) A research design where the effect of certain exposures are studied through comparison with a non-exposed control group. Which individuals are to be included in the exposed or the non-exposed group will be determined before the study starts through a random procedure.

Utility The pleasure or satisfaction received from consuming a good or service.

Utility in anticipation The value of the activity after the activity. Utility in anticipation of exercise can be better health (i.e. treated illness and/or decreased risk of illness), feelings of well-being, capability in sports or work, more attractive look, but also reduced anxiety of risk of ill-health. Environment of the activity can bring out future utility like long-term friendships. Negative utility in anticipation can also occur, such as aches and injuries [12].

Utility in use The value of the activity during the activity, and can be positive as well as negative. Examples of positive utility in use of exercise are reduction of pain, well-being, enjoyment and negative utility are pain, feeling of sickness, and gloominess. The effects can be a result of the activities in it selves, but also an effect of the physical and social environment for the activities [12].

Validity The ability of the study to capture what was stated in the aims. It includes absence of systematically measurement bias, and agreement between theoretical and empirical definitions of a phenomenon.
1. Background

In this section, the connection between physical activity, health and societal costs is discussed, as well as the physical activity of the population in general. In addition, methods for promoting physical activity, economic evaluation theories and rules for priority in the health care are described.

1.1. Physical activity and health

The motivation for an individual to perform physical activity may be for a variety of reasons such as health gains, well-being, physical and mental capacity, aesthetics, transportation and enjoyment. The motivation for health care professionals to promote physical activity is primarily the health gains for the individual. The following section will outline reasons why physical activity is appealing on the grounds of good health.

In recent decades, there has been a great deal of research on the relationship between physical activity and health. One very influential report originating from the U.S. Department of Health Services in 1996 was "Physical Activity and Health – A Report of the Surgeon General" [10]. The report draws conclusions not only regarding the relationship between physical activity and health, but also regarding methods of promoting physical activity in the population. These included:

- People of all ages, both male and female, benefit from regular physical activity.
- Significant health benefits can be obtained by including a moderate amount of physical activity (e.g., 30 minutes of brisk walking or raking leaves, 15 minutes of running, or 45 minutes of playing volleyball) on most, if not all, days of the week.
- Additional health benefits can be gained through greater amounts of physical activity. People who can maintain a regular regimen of activity that is of longer duration or of more vigorous intensity are likely to derive greater benefits.
- Physical activity reduces the risk of premature mortality in general, and of coronary heart disease, hypertension, colon cancer and diabetes mellitus in particular. Physical activity also improves mental health and is important for the health of muscles, bones and joints.

Since the publication of the Surgeon General’s report, a great deal of research has been published. However, the report’s conclusions are still a relevant starting point for describing the connections between physical activity and health. The following section also describes some of the important findings from research conducted after the Surgeon General’s report.

Overall mortality

Moderate to high levels of regular physical activity are associated with lower mortality rates for both older and younger adults, when compared to sedentary individuals. Physically active people have lower total mortality and a considerably longer life than physically inactive people [13-18].

Cardiovascular diseases

Physical activity and cardio-respiratory fitness are associated with a lower risk of cardio vascular disease and coronary heart disease mortality. Physical activity prevents or delays the onset of high
blood pressure, and reduces blood pressure in people with hypertension. Physical activity reduces the risks of both strokes and stroke subtypes [19].

Cancer
Physical activity decreases the risk of cancer in general. The association is most significant for colon cancer, breast cancer, prostate cancer, uterine cancer and lung cancer [20-31]. Unfortunately, data are too meager to be able to draw conclusions regarding a relationship between physical activity and either endometrial, ovarian, or testicular cancers.

Non-insulin-dependent diabetes mellitus
Physical activity is associated with a decreased risk of non-insulin-dependent diabetes mellitus (type 2 diabetes).

Obesity and metabolic syndrome
Regular physical activity or cardio-respiratory fitness decreases the risk of the metabolic syndrome [32-36]. Low levels of activity, resulting in fewer kilocalories being used than consumed, contribute to obesity. Physical activity may favorably affect body fat distribution. Physical activity (e.g. fitness) reduces the risk of all-cause mortality from being obese [16].

Osteoarthritis
Weight-bearing physical activity is of importance for normal skeletal development. It is unclear whether physical activity can reduce bone loss in postmenopausal women.

Mental health
Physical activity reduces the risk of depression [37-40], and is shown as being effective in treating mild to serious depression [38, 39, 41-43]. Physical activity can also reduce sleeping problems, anxiety, phobias, panic and stress-related illnesses [38, 39].

Health of the elderly
There is promising evidence that strength training and other forms of exercise in older adults both preserve the ability to maintain an independent living status and reduce the risk of falling. Physical activity also appears to reduce risk of dementia and Alzheimer’s disease [44, 45].

Health-related quality of life (HRQL)
Physical activity would seem to improve health-related quality of life. This is achieved through enhanced physiological well-being and by improved physical functioning in individuals with poor health.

Adverse effects
Musculo-skeletal injuries occur due to physical activity. However, appropriate physical activity can prevent most of these injuries. Serious cardiovascular events can occur with physical exertion.
1.2. Physical activity in the population

Physical inactivity among adults is estimated to be 17% worldwide, and insufficient activity (<2.5 hours per week of moderate activity) is estimated to be 41% [1]. The increase in structural exercise in western countries in recent years does not fully compensate for the decrease of physical activity in the workplace and during travel to and from work [46]. A British investigation [47] showed that general activity levels are currently declining as lifestyles change in Britain. Between 1975/76 and 1999/2001 the total distance traveled per year on foot and by bicycle fell by 26% each. An American study [48] showed a similar development; the percentage of journeys walking to and from school declined from 20.2% in 1977 to 12.5% in 2001.

The total energy expenditure can also been seen in comparison with people who are living in a traditional food gathering way. They may be an available indicator of the physical activity patterns for which our genetically determined biology was originally selected. People from western countries need to walk 19 km more each day to expend as much energy as people in a tribe in South America [49].

A Swedish national survey of physical activity for the population aged between 18-84 years [50] revealed that:

- 46% of women and 42% of men were physically active for a moderate intensity less than 30 minutes a day.
- 14% of both women and men were mostly sedentary at leisure time.
- Sedentary leisure habits were twice as common among people with low education compared to people with high education.
- Low-income groups were twice as likely to be sedentary as more affluent people.
- People from non-Nordic ethnic groups were two to three times more likely to be sedentary during leisure time than people with a Nordic heritage.

The distribution of physical activity is therefore shown to be unequal in society. Determinants for high physical activity levels are low age, high education and urban living. A sufficiently athletic education and friends who are physically active will increase the probability of a high level of physical activity. If all these factors are missing, then the probability of sedentary living is high [51].

Physical activity habits were investigated for 15 year old adolescents living in Stockholm, Sweden [52]. Spending many hours a day watching television and videos relates strongly to low education level (of the parents), foreign heritage and obesity. The prevalence of a sedentary lifestyle has increased, and the amount of sports outside sports clubs has dramatically decreased, which may be an explanation of why youths spend less time on sports. Very few youths, outside members of sports clubs, are exercising several times a week [53].
1.3. Physical inactivity and illness in the population

According to the World Health Organisation (WHO), physical inactivity causes a total of 1.9 million deaths annually, and the loss of 19 million disability adjusted life years (DALYs) globally. Physical inactivity is estimated to cause 10-16% of all cases of breast, colon and rectal cancer and diabetes mellitus worldwide, and about 22% of ischemic heart disease [1]. Physical inactivity is one of the ten largest risk factors of premature death in developed countries [1].

The WHO has estimated that 80% of heart and cardiovascular diseases, 90% of non-insulin-dependent diabetes and 30% of all cancer can be prevented merely by a change of lifestyle. This would include altering bad eating habits, quitting smoking and participating in the desired amount of physical activity [1]. Despite the mostly favorable development of health in the population are there some diseases, which are on the increase. These include obesity and the connected metabolic syndrome, and type 2 diabetes, both of which can contribute to cardio-vascular disease [1].

Within the Organisation for Economic Co-operation and Development (OECD), consisting of 30 of the worlds most developed countries, physical inactivity is estimated to cause 12% of all mortality, 8% of all lost years as a result of premature death, 2% of lost years as a result of morbidity, and 5% of the burden of disease [54]. Other international estimations of ill health due to physical inactivity include 9.5% of all deaths in New Zealand [55], 9% of men’s and 12% of women’s deaths in Australia [56], and 6% of death in The Netherlands [57].

Physical inactivity is estimated to cause 6% of the burden of disease for men and 3% for women in Sweden [58].
1.4. Physical inactivity and societal costs

Physical inactivity has a broad impact on societal costs. The costs are significant as regards
• health care,
• lost productivity due to absence from work,
• lost productivity due to unfitness,
• social services due to a person's inability to perform daily activities in home, especially for elderly,
• the individual's and their relative's for transportation etc.

It is difficult to determine the total cost of physical inactivity on society, especially since only a fraction of the costs can be estimated. In a study from the USA [59], 2.4% of health care costs were estimated to be as a consequence of physical inactivity. Costs were calculated as being 22% of cardiovascular heart disease, 22% of colon cancer, 22% of osteoporotic fractures, 12% of diabetes and hypertension, and 5% of breast cancer. In the same study, costs arising from obesity (BMI >30) were estimated to be 7% of health care costs. In a Canadian study [60], the economic burden of the direct health care costs of physical inactivity was estimated to be 2.5% of health care costs. Diseases included in the study were coronary artery disease, stroke, colon cancer, breast cancer, type 2 diabetes mellitus and osteoporosis. In a British calculation [61], the societal costs were estimated to be 8.2 billion pounds. For a population of 9 million people, such as in Sweden, these costs correspond to 18 billion SKr. Diseases included were angina pectoris, myocardial infarction, stroke, colon cancer, type 2 diabetes, hypertension, osteoarthritis, depression and back pain. In a Swedish report [62], the costs of physical inactivity were calculated at 0.4% of the health care costs, and 3% of losses in production due to illness. The same method was used as that of the USA and Canada for estimating health care costs. Production losses are calculated in respect of premature death and retirement, but not for absence due to illness. In a British study [63] it was determined that there are strong economic arguments in favor of the value of exercise in adults aged 45 years and more, but not in younger adults. Indirect effects of physical activity, such as obesity, have not been considered in these calculations.

In 1983, a British study found that sedentary people were shown to consume more benefits from collectively financed programs such as sick leave and health, disability, and group life insurance than moderately active people. Because they on average die 10 month earlier, they pay lower lifetime taxes on earnings, and collect less in public and private pensions. As a result of these differences, the sedentary person imposes US$9,300 in lifetime external costs and US$1,650 in discounted lifetime external costs [64]. The investigation was controlled for physical disability (not able to exercise) and for heavy drinkers, but not for other lifestyles that may correlate to a sedentary lifestyle. Smokers were also studied as the previous study and the costs of a sedentary lifestyle were larger than for smoking.

In an American cross-sectional stratified analysis [65], the annual direct medical costs were found to be US$330 higher for those who were reported as being inactive, compared to those who were reported being physically active on a regular basis. The study was controlled for physical limitations, age, sex, and lifetime smoking status.

A Danish analysis from 2005 [66] reported that if an 30-year old physically inactive person became moderately active, the expected gains in production were an estimated 65,000-78,000
Danish crowns (80,000-100,000 SKr), calculated using the human capital method and discounted by 5%. When the friction method was used, savings were estimated to be 9,000-15,000 Danish crowns (11,000-19,000 SKr). The costs of health care would decrease by 27,000-29,000 Danish crowns (34,000-36,000 SKr) and the increased lifespan was estimated to limit the reduction of health care costs to 18,000-24,000 Danish crowns (22,000-30,000 SKr). The analysis was controlled for smoking, alcoholic consumption, socioeconomic factors, BMI, increased blood pressure and cholesterol.

In Sweden in 1995, the societal cost as a result of heart disease was 34,000 SKr per patient, and in 1994 for diabetes mellitus, 50,000 SKr per patient [67]. In 1991, the societal costs in Sweden as a result of motion pain were ten times the costs of diabetes mellitus [67], but estimations per patient, such as for diabetes mellitus, is not done.

In 2000, the total annual direct health care costs in Sweden for type 2 diabetes were estimated to be about 7 billion SKr, which is about 6% of the total health care expenditure. The annual per-patient cost was about 25,000 SKr [68]. Health care costs of about 1 billion SKr are due to physical inactivity, according to the estimations of the WHO [1].

The metabolic syndrome can be prevented with physical activity, good eating habits and weight loss. The standard treatment is through the administration of various drugs over a number of years for a significant part of the population. Hence, the costs of drugs are high. Drugs for reducing blood pressure, blood fat and blood sugar account for 15% of Swedish drug costs [69].
1.5. Methods of promoting physical activity

It should be the responsibility of health care to promote physical activity as a means of improving health and quality of life. However, there are few resources explaining just how health care providers might promote physical activity among their patients. The Cochrane Collaboration review states that promotion of physical activity in health care can be moderately effective, but more research is needed to establish which method of exercise promotion works best in the long-term to encourage different types of people to be more physically active [70]. Most trials of promoting physical activity have been based on advice, counseling and behavior modification, but there are also trials that offer structural exercise programs [70]. Most interventions seem to be designed to help individuals get started, but do not give sustained support.

The Swedish Council on Technology Assessment in Health Care (SBU) recently reviewed extent of the knowledge of promoting physical activity in the health care system [71]. The major findings of their report were as follows:

Advice, counseling

Advice and counseling to patients within the health care system is generally followed by increased long-term physical activity (6 months and longer). It was not possible to draw any conclusions of the most effective method of delivering advice and/or counseling or for which groups of patients it is done with greatest effectiveness. There is some evidence that more advice/counseling results in increased physical activity.

Behavior modification

Intervention based on behavior modification increases a patient’s physical activity level more than usual care. Greater intensity may result in more physical activity. Behavior modification is probably as effective in promoting physical activity as offering participation in exercise groups. An intervention including lifestyle in it’s whole (physical activity, nutrition, stress managing) strengthening the effect on the individual's physical activity.

Exercise groups, exercise schedules

Supported exercise groups for patients with cardiovascular disease can result in increased physical activity. The same positive results are shown for patients with peripheral arterial occlusive disease and chronic obstructive lung disease.

Physical activity on prescription

In many countries, an increasingly popular way for health care to promote physical activity is through physical activity on prescription. When well designed, it consists of a range of activities including counseling, exercise schedules, the possibility of joining exercise groups in the community, support and follow-up. In a review of 22 studies [72], most reported increases in physical activity levels or fitness for a term of 6-12 months. Participants in intervention groups were found to have increased their levels of physical activity by 10%, when compared to their controls.
Intervening through mediators of physical activity

Why an intervention is effective in promoting physical activity is not clearly understood, but it may influence physical activity levels by changing theoretical constructs, such as behavior processes, self-efficacy, and social support [73, 74]. In a review [75] of behavioral determinants of exercise in physical activity interventions, favorable aspects included increased motivation for physical activity, enhanced self-efficacy for exercise, enhanced social and environmental support and tailored interventions for subgroups. These factors can be called mediators of physical activity changes, and has by Bauman et al. [9] been called intervening causal variables that are necessary to complete a cause-effect pathway between an intervention and physical activity. Assuming an intervention works by means of mediating factors, the limit of an intervention is governed by the effectiveness of the mediating factors. Few evaluations of interventions have included mediating factors, and those that do rarely analyze both an intervention’s effect on the mediating factors and the mediating factors’ impact on changes in physical activity levels [76].

Interventions aimed at promoting physical activity rarely show the importance of the influence of enjoyment. In a review [77] of psychosocial mediators of physical activity behavior among adults and children, it was impossible to draw any conclusions from the few studies using suitable statistical methods. Nevertheless, there is some evidence regarding the impact of enjoyment on physical activity. A population-based survey among adults revealed that high enjoyment correlates to high level of activity [78]. Finnish male officers were studied and enjoyment was found to be the most powerful determinant for both physical activity and fitness [79]. The impact of enjoyment was evaluated in a study of a high school-based intervention aimed at promoting physical activity. The enjoyment of both physical activity and physical education was found to positively influence self-efficacy beliefs about participating physical activity, and mediated the effect of the intervention [80]. Additionally, an investigation among ”senior games participants” showed that physically active individuals were most likely to agree that recreational enjoyment or fun motivated their physical activity, whereas sedentary individuals were most likely to agree that improving the quality of life motivated activity [81].

Exercises on prescription schemes have also identified a number of implications encouraging lifelong participation in sport and exercise. One such implication is the development of a model for understanding participation that shifts the emphasis away from a focus on motivation and behavior change per se and towards satisfaction and enjoyment through development of skills and relationships [82]. Behavior interventions for promoting physical activity have mostly worked when participants were motivated enough to volunteer, or when a physical activity education program changed. Behavioral or psychosocial theory has accounted for 30% or less of the change in physical activity behaviors. Research should therefore focus more on the impact of interventions on mediating factors as well as the relationships between mediating factors and outcomes [76].
1.6. Economic evaluation of promoting physical activity

1.6.1. Introduction

Despite the obvious and substantial health benefits in being physically active, a large part of the population is either inactive or barely physically active. In view of this, the main question is:

Consequently, this begs the question of how health care should respond when the population and the patients are either inactive or rarely physically active.

The promotion of physical activity can be regarded as a health care intervention, alongside other treatments such as drug therapy and surgery. This perception has consequences for economic analysis because health care cannot be considered as a standard economic commodity. Health care has three intrinsic characteristics: uncertainty of illness incidence, external effects in consumption and asymmetry of information between provider and user [8]. One can even add that demand is derived and related to the expected utility of better health for the individual. These characteristics will now be discussed in the context of health care induced physical activity.

Derived demand for health care (and physical activity)

In standard economic theory, it is assumed that individuals strive to maximize their utility, often defined as the satisfaction derived from consumption of a good. When consuming standard health care, the direct effect on utility/well-being is often negative, while the effect through improved health is positive. Thus, the demand (or need, see chapter 1.6.2.) for standard health care is derived only from its effects on health. The consumption itself is normally not pleasant. "Anyone who seeks care when he is not sick, is sick" [8]. However, demand for physical activity may also be derived from its effects during participation. In Sweden, there is a common expression "Träna för nytta och nöje", which means, "Exercise for health and pleasure." An equivalent notion in economic theory for these values is utility, which covers both health and pleasure. There are several definitions of utility, but in a broad sense the notion has always been synonymous with preference; the more preferable an outcome is, the more utility is associated with it [84]. Hence, all goods for an individual or society are included, not only goods for health. The following section discusses how utility theories can be applied to the goods of physical activity.

The motivation for an individual to perform exercise is the resulting effects of that exercise (goods). These will appear at different times: during the exercise, at the end of exercise, long after the performance. The most direct effect is the experience had during exercise, and the most long lasting effects are health effects such as the treatment of illness, decreased risk of illness, fitness, and lower weight/improved appearance.

Effects during the performance can be positive (utility) as well as negative (disutility). Positive effects are feelings such as enjoyment, happiness and well-being. Negative effects include pain, suffering and gloominess. Even more additional indirect effects are possible. Exercise is often viewed in a social context and may create new friendships. Effects experienced during participation can be defined as utility in use [12].
Effects after participation are mostly supposed to be positive and desired. Hence, exercise can be regarded as an investment in utility (health) and can be defined as utility in anticipation [12]. Negative effects such as injuries and aches can also appear. These are similar to side effects of medical treatment.

The effects in term of utility can differ between individuals due to varying preferences, such as for health, fitness and appearance.

**Uncertainty of illness incidence and physical activity**

For the individual, illness and injury are, to a great extent, random and therefore the demand for health care (or physical activity) is uncertain. Furthermore, a treatment may prove effective in general, but it is impossible to determine beforehand whether it will be effective for a particular individual. Hence, it is not obvious to an individual that he will receive benefits from physical activity.

Different individuals have different risk attitudes: some individuals shy away from more risky alternatives in favor of less risky alternatives. Other individuals prefer risky situations [84]. Consequently, the risk of illness incidence due to physical inactivity is also valued differently.

**External effects and physical activity**

The societal utility of an effort can be both greater than and less than the utility to an individual. External effects exist when these are not equal, which means that individuals not involved in the market transitions can also be affected. For instance, the promotion of physical activity among women may also affect the men they are living with.

External effects may also be to the contrary. A sedentary lifestyle will create external effects through poor health [64]. It is not only poor health per se that matters from an economic perspective, but also the costs borne by others. Many of the negative consequences of inactivity – reduced health-related quality of life, lost wages, higher out-of-pocket medical expenditures – are borne by inactive persons themselves, who may also be receiving some benefits and enjoyment from being inactive. External costs include collectively financed expenditure such as insured medical expenditures or paid sick leave. Free health care and social insurance, may actually “promote” a sedentary lifestyle. These almost free goods decrease the individuals’ utility of performing physical activity, because the economic effects of illness for sedentary individuals will not be as dramatic as if the individuals had to pay all their own expenses.

The feeling of not being safe when walking and cycling is another external effect that has impact on physical activity. According to an American study [85], a large majority of respondents felt safe when asked about traveling on highways, commercial airlines or intercity trains. However, 58% felt unsafe traveling by bicycle and 43% felt unsafe as a pedestrian. These external costs of driving actually make driving more attractive than being economically efficient and socially desirable.

There may also be other external effects related to physical inactivity, such as an individual suffering from seeing another’s illness due to physical inactivity and impact on the environment from the mode of transportation (car instead of bike).

**Informational asymmetry and physical activity**

Information asymmetry exists when one party has more or better information than another party, which makes it possible for the better-informed party to exploit the less-well-informed
party. Information asymmetry is very common in health care. As a result of information asymmetry, patients will not purchase care (or perform physical activity) that they would have done were they well-informed. A complementary approach to informational asymmetry is use of an agency that will be highlighted in the context of promoting physical activity. When health care acts as an agent for the patient, it is expected to act in the interests of the patient and not in self-interest [83].

It may be too complicated for the individual to estimate the complete lifetime utility of physical activity. It would be hard for a child and its parents to estimate the utility of physical activity during the child's formative years. Equally difficult would for an individual who never has been physical active, to try and estimate the positive effect of being fit. Some may overestimate the effects of physical activity while others may underestimate the importance of the same effect. Many of the public sports facilities, swimming pools and activities subsidized by society would rarely have been used if individuals had to pay the full expense.

1.6.2. Normative aspects

Normative aspects is concerned with the attempt to rank in descending order, from an economic perspective, both resource allocations and the policies that generated them. There is a debate about the most appropriate framework for conducting normative analysis in health care, focusing on the welfarist and extra-welfarist frameworks.

Welfarist framework

In neo-classical welfare economics, four tenets are of particular interest for normative analysis in health care; utility maximization, individual sovereignty, consequentialism and welfarism [86]. Utility maximization is an assumption that individuals choose rationally. It excludes all non-utility aspects of the situation, such as fairness in consumption opportunities. From a given set of options, an individual is assumed to be able to rank and choose the most preferred. Individual sovereignty means that an individual is the best judge of his own welfare. Consequentialism assumes that only the result or outcome matters, not the process. Finally, welfarism is the proposition that the utility level of any situation attained by an individual is the sole basis for judgment.

Utility is mostly regarded as cardinally immeasurable data (i.e. not measurable with an interval scale, with or without a point zero) and therefore it is not possible to compare different individuals’ utility. Consequently, ordinal utility theories for decision-making have been developed. An important concept in welfare theory is the notion of Pareto optimality. Pareto optimality is a situation where it is impossible to improve the situation of some individual without making at least one other individual worse off [87].

"Pareto optimality encompasses at least two concepts: Pareto improvement and Pareto efficiency. A Pareto improvement occurs if a re-allocation of resources increases the utility of all individuals in an economy. A weaker version states merely that some individuals must gain from the re-allocation. If there are some gainer and some losers then it is not possible to rank the re-allocation outcomes with reference to the Pareto improvement criteria; the states are said to be Pareto non-comparable." [88]
"Pareto efficiency is a more powerful concept. It defines the central notion of efficiency as follows: a re-allocation of resources is said to be efficient if at least one individual in the economy is made better off and no other individuals is made worse off. The definition turns out to be generally rather useful. It is weak, however, in the sense that many changes in economic circumstances in real life involve the suffering of some and, if this is the case, we require some means of interpersonal comparison to adjudicate over the optimality of the re-allocation." [88]

The so-called Hicks-Kaldor criterion was developed to overcome these shortcomings [89]. The gainers’ willingness to pay for the new state is compared to the losers’ willingness to accept compensation for the new state. If there are net gains, then the re-allocation is desired [90]. This criterion is also called the Potential Pareto Improvement, based on the fact that compensation measures are hypothetical.

However, there is damaging criticism of Pareto Optimality.

"First the Pareto criteria are compatible with a large number of potential allocations some of which represent highly inequitable resource allocations. Pareto optimality is optimal only in one dimension: it is indifferent to the distribution of utilities across individuals. Second, note that we have already stated that Pareto optimality cannot rank all states; the Pareto Improvement criteria are inconclusive across resources allocations where some gain and others lose.” [88]

The Bergson-Samuelson welfare function has addressed this issue [91, 92]. A social welfare function should encompass more than just utilities, for instance, desired distribution. According to this criterion, a re-allocation of resources is beneficial if social welfare, defined across the utility levels of individuals, increases.

The welfarist framework is connected with the economic measuring of all costs and benefits in monetised values, often including an individual’s willingness-to-pay for a commodity.

The Extra Welfare Framework

The welfare framework has been criticized from several viewpoints. Individual sovereignty is relinquished in health care, hence measurements such as willingness-to-pay lose normative relevance. A number of investigators have argued that other types of interpersonal comparisons are important in addition to utility comparisons [93-95]. It is preferable to consider these other types of comparison separately from the interpersonal comparison restricted to utility measures alone. In conducting normative analysis in the health sector, it has been argued that health is an especially important aspect of welfare functions [93]. The extra welfare framework differs from the welfare framework in two key concepts: the concept of need instead of demand, and the concept of health instead of utility [93].

A measure for both personal and interpersonal comparison in the health care sector would be based on the health state of the individual. Quality adjusted life-years (QALY) is often used, but what precisely QALY is a measure of, is a matter of debate. It can be regarded as measuring health benefits alone, but also regarded as being a measure of preference or utility for a health outcome. QALY has often been used as a measurement of preference, based on expected utility theory [96-98]. This theory is an estimation of behavior under uncertain conditions and includes...
several assumptions [99, 100]. Individuals are assumed to choose between options in a logical way, and be able to judge utility for different health states. Individuals are also supposed to choose in a consistent manner, and the individual is assumed to find states with the same utility level to be interchangeable. Further, quality-of-life for an individual in any given time period is independent of the quality-of-life for that individual in any other time period [84]. In order to use QALY as a measure of preference for health states, another two assumptions are necessary. Firstly, individuals are supposed to have a constant proportional time trade-off: the willingness to sacrifice life-years for better health needs to be the same over time. Secondly, the risk preference is supposed being independent of the individual’s utility function, and therefore is characterized by constant proportionality with respect to risk [101].

As a measure of preference or utility, QALY is limited to not interpersonal comparisons. For interpersonal comparisons, QALY must be shown to reflect a cardinal ratio scale [102, 103], which has not been shown, and examples exist of how QALY fails to meet expected utility theory [104]. An alternative interpretation of QALY, not based on expected utility theory, is as a measure of health-benefits (but not utility), which makes it possible to define QALY as a cardinal measure (i.e. interval data) of health benefit [93, 104]. In this case, the QALY weights are based on preference for health states, and put on a scale bounded by perfect health at one end and death at the other. These two points are the reference points for each individual’s preference for all other health states.

Some think it does not matter if QALY is utility or not [93]. QALY may be a good, basic measure of what health care are trying to achieve, and maximizing QALY can be an appropriate objective [84]. This view is based on the extra welfare framework, and can be a foundation for cost-utility analysis [84].

1.6.3. Methods for health economic evaluation

In this chapter, methods for analysis of interventions are presented. Standard methods for economic evaluation of health care programs are also described, followed by a summary of theories for estimating costs of time.

Promotion of physical activity in health care is competing with medical treatment therapies for priority within a restricted budget. The most common method for evaluating these medical treatment therapies is based on circumstances that do not always exist for, or suit, interventions aimed at promoting physical activity. Hence, when the promotion of physical activity is compared with other therapies in health care, the question arises whether it should be based on the same evaluation method for both. Aspects for further discussion include whether efficacy or effectiveness should be evaluated, and whether randomized controlled studies (RCT) should always be used.

Standard methods for economic evaluation

In general, there are four main methods of analysis for economic evaluations of interventions in health care [84]. All of them are constructed to compare different programs. The methods for calculating costs are the same, but they differ in their principles for dealing with consequences, which can be assumed as either not existing or can be expressed in health units, utility or money. See Table 1.
In a discussion regarding which analysis method is most appropriate for the evaluation of interventions aimed at promoting physical activity, numerous guidelines for the economic evaluation of health care can be used. The WHO has based its recommendations for evaluation methods upon these guidelines [105]. Their aim is to make cost-effectiveness studies as comparable as possible.

According to the WHO’s recommendations, cost-benefit analysis should not be used. When the individual’s willingness to pay is used to judge cost-effectiveness, a number of assumptions are needed. Individuals need perfect information on the consequences of their choices as well as training in the valuation of benefits. Most cost-benefit analyses are based on potential Pareto improvements, where the winners would, in principal, be able to compensate the losers. However, if redistribution not is done, an increase in welfare will not necessarily exist, and redistributions seldom occur. Another problem with cost-benefit analysis is that an individual’s willingness to pay cannot be considered together with savings in health care costs and in the production, because of the risk that benefits are considered twice [84].

Cost-effectiveness analysis (and cost-utility analysis, which is sometimes also seen as a cost-effective analysis) is based on the assumption that health contributes to social welfare separately from the consumption of other goods and services [93]. According to the WHO’s guidelines, the benefits of an intervention should be the welfare gains resulting from any health improvement, and the costs should represent the welfare forgone because the resources could not be used in the next best use [105]. Hence, according to the WHO’s recommendations, cost-utility analysis should be most appropriate.

When deciding if the promotion of physical activity should be used in health care, it is a decision within a restricted budget. This means that decision-makers need to compare the promotion of physical activity with other efforts in health care. Hence, analysis should be done in a way that the cost-effectiveness of an intervention could be compared across the different treatments and prevention methods of health care.

Physical activity influences an individual’s well-being in many ways and cannot adequately be measured in single-effect terms like blood pressure readings. Effects of physical activity can

<table>
<thead>
<tr>
<th>Type of study</th>
<th>Measurement/valuation of costs in both alternatives</th>
<th>Identification of consequences</th>
<th>Measurement/valuation of consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost-minimization analysis</td>
<td>Dollars</td>
<td>Identical in all relevant aspects</td>
<td>None</td>
</tr>
<tr>
<td>Cost-effectiveness analysis</td>
<td>Dollars</td>
<td>Single effect of interest, common to both alternatives, but achieved to different degrees</td>
<td>Natural units (e.g. life years gained, disability-days saved, point of blood pressure reduction, etc)</td>
</tr>
<tr>
<td>Cost-utility analysis</td>
<td>Dollars</td>
<td>Single or multiple effects, not necessarily common to both alternatives</td>
<td>Healthy years or (more often) quality adjusted life-years</td>
</tr>
<tr>
<td>Cost-benefit analysis</td>
<td>Dollars</td>
<td>Single or multiple effects, not necessarily common to both alternatives</td>
<td>Dollars</td>
</tr>
</tbody>
</table>

*Table 1: Measurement of costs and consequences in economic evaluation (from Drummond et al [84]).*
be expressed relative to health aspects such as reduced risk of illness, less illness, increased well-being, increased capability (physical and mental) and better appearance. All these aspects may have value for the individual and hence, depending on the point of view, have impact on the cost-effectiveness ratio for an intervention.

Cost-utility analysis with outcomes expressed as health related benefits such as QALYs would be a suitable method for economic evaluation of the promotion of physical activity.

Costs of time

Evaluations of cost-effectiveness should be done from a societal perspective [84, 106]. From this perspective, time spent on exercise is usually one of the greatest inputs in an intervention to promote physical activity. In their guide to cost-effectiveness analysis, the WHO stated that volunteer time should always be identified and included unless deemed to be minimal [106]. In a review of articles concerning the cost-effectiveness of promoting physical activity in health care, 26 articles were found, with six concerning costs of time for exercise [107]. In none of the articles were time costs valued by the participants. Instead, assumptions about the time costs were made.

There are a number of existing studies on the value of informal care [108-114]. Informal care can be defined as

"A nonmarket composite commodity consisting of heterogeneous parts produced (paid or unpaid) by one or more members of the social environment of the care recipient as a result of the care demands of the care recipient." [8]

The time spent on exercise should be considered part of this informal care, but in this case the care producer and the care recipient are the same individual.

Several methods for valuing informal care are discussed in the literature; the three most frequently cited are the Human Capital Method, the Friction Cost Method, and the Washington Panel Approach. These approaches have already been reviewed and critiqued elsewhere [108], and are summarized below.

**Human Capital Method**

In the human capital method, participation in health care programs is equated with investment in health capital, implying that humans have a stock productive ability, which can be increased. An investment in human capital is measured by the return of healthy time produced; this value is approximated by an individual’s increased production.

The theory has several basic assumptions, such as full productivity and full employment in the market, and presumes that the labor market is competitive [115-117]. Furthermore, transaction costs are assumed to be insignificant. An individual’s workplace productivity is assumed to be a result of his stock of human capital. It is assumed that employment is paid (at the margin) with wages in direct proportion to the employee’s contributions to the firm. The human capital method does not consider the value of unpaid labor or the loss of leisure time, but these values can be estimated by a broad interpretation of the method.

To utilize the human capital method, the value of informal care is calculated in time losses, depending on the activity foregone. Paid work time foregone is valued as the wage foregone,
and unpaid work time forgone is valued with a shadow price using the opportunity or replacement cost approach [118]. The opportunity cost calculates the value of time for informal care, and this is regarded as being equivalent to wages foregone. The replacement cost is the cost of hiring a replacement worker. Pure leisure time foregone can be valued using the marginal value of work. A basic assumption is that an individual is free to choose the amount of work and that the disutility of work is incorporated into wages [118].

This method has been criticized from several viewpoints: it does not value life beyond economic productivity, unpaid work is not explicitly accounted for, production losses to society might be smaller if replacement workers are hired, and the method favors groups with high income.

Friction Cost Method
The friction cost method is based on the points of view of the firms, consumers, and society; the potential income loss of the individual is not accounted for [119]. This method calculates production losses for the time it takes to replace a sick worker with a new, previously unemployed worker. The friction period is the time taken for a new employee to be hired and trained, and the friction costs are the costs incurred in carrying this out. The underlying assumption is that the economy is not operating at full employment, and so unemployed replacements are available [120]. Productivity costs are calculated as the sum of the value of production loss, the extra costs needed to re-establish the previous production level, and the costs of hiring and replacing an individual [121]. However, the friction cost method does not value lost leisure and unpaid work time [118, 122].

The method has mainly been criticized because it does not originate from neoclassical economic theory, and that profit-maximizing firms will hire workers only until the marginal cost of labor equals the wage rate. Its assumptions regarding the amount of friction costs have also been criticized. More complex work will be associated with longer friction periods, and unskilled work with shorter; hence, time is valued differently in different socioeconomic groups.

Washington Panel Approach
This method is recommended by the Panel of Cost Effectiveness in Health and Medicine (the Washington Panel) and stipulated by the US Public Health Service [123]. It differs from the other approaches in terms of the time lost to receiving care, and losses related to morbidity and an individual’s impaired ability to be productive in both work and leisure [124]. With this approach, only the time lost to receiving care should be monetarised; productivity losses due to morbidity and impaired ability should be measured in terms of quality of life (QoL). Patients are assumed to combine the effects of time loss, income, and illness when reporting QoL [113], and so double counting may occur if both productivity losses and changes in QoL are reported.

The opponents of this method have criticized its incorporation of the effect of lost income into QoL, and hence the denominator in cost-effectiveness analysis. According to these critics, QoL should only include the health status from the patient’s perspective; they argue that income effects are not a part of health-related QoL. Others claim that the relationship between productivity, income, and QoL is incomplete. It is argued that only the total income losses affect the QoL valuation, and that these may not be proportionate to productivity losses. Further, the time losses for unpaid caregivers are not accounted for.
Conclusion

Each method has both advantages and limitations. The focus has been on methods for valuing the time and productivity losses of care recipients, but not the time losses of unpaid caregivers. The human capital method gives some help in valuing the unpaid caregiver and unpaid labor/leisure time, but the other two methods do not [121, 123]. The unpaid caregiver’s time may be valued by a shadow price, using the opportunity or replacement cost approach [118]. Some have suggested that patient’s leisure time losses may be best measured through effects on QoL [123]; this approach allows individuals to view the time spent caring as an improvement of or benefit to their QoL and not as a cost. There is no consensus in valuation methods.

Efficacy or effectiveness analysis

Efficacy studies analyse the results of an intervention using relatively ideal participants and circumstances. Effectiveness studies analyse the impact of an intervention for the general population or some targeted subgroup in a real-life setting, and effectiveness will be a combination of efficacy, population penetration, and participants adherence [11].

Medical interventions are mainly evaluated by efficacy studies, however the generalisability of the results from these is often low [125]. The setting may be unrepresentative for general clinical practice, and the professionals involved may be more experienced and more strongly motivated than those in standard care. Hence, patients who participate may receive better care than usual. The patients may also be unrepresentative due to exclusion criteria that cause participants to represent only a small proportion of patients being treated in normal practice. Interventions aimed at promoting physical activity need to consider adherence to recommended physical activity [11]. Many possible physical activity schedules may have high efficacy in creating health, but patients are either unable or unmotivated to follow them, or adhere to uncomfortable routines. Also of interest to public health is the extent to which the target group would be helped by the intervention, i.e. would accept and adhere to the recommended physical activity [11].

At the beginning of an intervention, the motivation of the participants for becoming physically active needs to be considered. The main question is whether it is possible to make generalizations from the group of participants. In one way or another, study participants are always volunteers, but the method of recruiting participants can differ. Participants that have been included after answering an advertisement would generate greatly different generalizations to a target group at a clinical practice that has been asked to participate. Indeed, it would have to be considered whether either group was truly representative, or just corresponded to the most motivated individuals.

The conclusion is that the promotion of physical activity should be evaluated with reference to effectiveness, not only efficacy. When comparing the promotion of physical activity with other therapies, it should be done based on effectiveness studies.

Study design

RCT is mostly regarded as the “golden standard” for evaluation in health care. For evaluation of interventions aimed at promoting physical activity, RCT may often, but not always, be the best choice. It can be difficult to create working circumstances for RCT of effectiveness in regular clinical practice. RCT has limitations in some situations, and the following points are relevant for the promotion of physical activity [125]:
• When the outcome of interest is far in the future. As an alternative, retrospective observational studies can be used to obtain some information on long-term outcomes.
• When the act of random allocation may reduce the effectiveness of the intervention. This arises when the effectiveness of the intervention depends on the individual’s active participation.
• When there is risk of contamination, for instance, when a clinician is expected to provide care in more than one way; the way they provide care to patients in one arm of the study may influence the care in the other arms.

With the aim making public health interventions more evidence-based, the TREND (transparent reporting of evaluation with non-randomized design) has developed guidelines for non-randomized evaluation [126]. It is a similar work to the CONSORT (consolidated standard of reporting trials) statement for randomized trials [127]. According to TREND, evaluations of public health interventions will necessarily entail the use of research designs other than controlled trials. It will be acceptable to use other research designs than RCT in following situations:
• When the intervention is already well established or its delivery is by nature widespread. For instance, evaluation of child welfare or a national advertisement campaign for some public health topic.
• When the intervention has been shown to be efficacious or effective in small-scale studies conducted under ideal conditions. However, its effectiveness needs to be shown.
• When the intervention is multi-faceted and the pathways to impact are complex. For instance, when additional evidence is needed to show changes in intermediate process outcomes, and differences between adopters and non-adopters of the intervention.
• When ethical issues do not allow use of a control group, or when patient choice needs to be factored in.

Evidence-based medicine has been defined as

“The conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence-based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research.” [128]

The best available external clinical evidence means clinically relevant research, not only restricted to RCT and meta-analyses. RCT should be used to answer questions about efficacy of therapy, but enquiries about number of patients suffering from the actual disorder, and the prognosis, require cross-sectional studies and follow-up studies [6].
1.7. Policies for priorities in health care

Both economic and public health perspectives play an important role in the policy formation process, and interventions supported by both perspectives are most likely to be effective and politically acceptable as well as having the greatest potential for success. Economic and public health perspectives can complement each other, although harnessing their synergy requires an understanding of both perspectives. The economic perspective was presented in the previous chapter, and this chapter presents the public health perspective from the Swedish health care point of view.

The parliament in Sweden has decided the policy of public health care, but the health care authorities have a great deal of both power and responsibility. Here follows a summary of the most important Swedish national policies.

The Swedish Health and Medical Service Act

In the first instance, the Swedish health care system is governed by the Swedish Health and Medical Service Act [129]. The second paragraph states that the aim of the health care system is good health and equal conditions of receiving care for the whole population. Care shall be given respecting both the patient’s dignity and the principal that all people are of equal value. Priority for care is given to those in greatest need. The preparatory to the law states that even patients with non-acute or minor illness are entitled to be treated within a reasonable time. Society has an obligation to place care at the disposal of all patients, within the boundaries of accessible resources and knowledge. It is of especially importance to defend the entitlements of vulnerable people, such as the elderly and people with disabilities.

There are two points of particularly importance in promoting physical activity; Firstly, the patient shall be informed of his/her state of health and any feasible methods of treatment. Secondly, patient should, when appropriate, be given information on methods to prevent injury and illness. Based on current understanding of the relationship between physical activity and health, this can be interpreted in relation to physically inactive patients as follows: the health care system must, where appropriate, provide information regarding methods of treating and preventing illness through physical activity.

Health Care Policy and Legislation

The revised Swedish Health and Medical Services Act [130] was influenced by the final report of the Swedish Parliamentary Priorities Commission. Priorities in Health Care [131], laid down the priorities for the health care, which were to be based on an ethical foundation consisting of three basic principles:

- The principle of human dignity: All human beings are of equal value, independent of their personal characteristics and functions in society,
- The principle of need and solidarity: Resources shall be addressed towards individuals with the greatest need as well as towards those less able to voice their needs or exercise their rights,
- The principle of cost-effectiveness. There should be a reasonable relationship between cost and effect (of health and quality of life).
The principle of human dignity is considered superior to the principle of need and solidarity, which in turn is considered superior to the principle of cost-effectiveness. Guidelines for priorities within the health care are based on these ethical principles, divided into four groups in descending degree of urgency.

**Group 1**
- Care of patients with serious diseases.
- Care of patients with diseases which, without care, could lead to permanent disability or premature death.
- Care of patients with chronically diseases.
- Palliative care and care in the final stages of life.
- Care of those with reduced autonomy.

**Group 2**
- Prevention.
- Rehabilitation.

**Group 3**
- Care of patients with less serious, acute and chronic diseases.

**Group 4**
- Care of patients for reasons other than disease or injury.

Both acute and chronic diseases differ in seriousness from time to time. Hence, the care of a single patient might be in different priority groups from time to other.

For each group of diseases, all clinical achievements regarding the disease are in the same priority group. This means that all effective achievements, such as diagnosis, treatment, nursing, rehabilitation and prevention of the disease, shall have the same priority. Hence, preventive achievements will be within Groups 1-3. The prevention referred to in Group 2 is not disease-specific prevention. Physical activity can be a part of rehabilitation after heart infarction under Group 1, promotion of physical activity among inactive people can be included in Group 2, and exercise programs for patients with mild arthritis can be included in Group 3.

These guidelines of priority involve many decision makers in the health care. Decisions of priority used to be divided into horizontal and vertical bands. Horizontal banding involves a decision regarding a sphere of activities, usually with politicians as decision makers, and vertical grouping is a decision regarding types of achievement within a sphere of activity, with medical authorities as decision makers. Today, medical authorities may make most of the decisions regarding the promotion of physical activity.

**The National Board of Health and Welfare guidelines**
The National Board of Health and Welfare are commissioned by the Swedish Government to develop evidence-based guidelines for health care. These guidelines are aimed at establishing skills and knowledge for authorities working with health care programs and priorities. The
guidelines are founded on an evidence base drawn from systematic reviews of medical, health, economic and scientific documentation of best practice. In these works, a trade-off between need and cost-effectiveness is sometimes necessary. An example of this trade-off is the government’s decision regarding subsidized medicine within the benefits of subsidized drugs, where details are given of how the principal of cost-effectiveness should be used. According to the government’s instructions to the Pharmaceutical Benefits Board, the starting-point should be a clear set of criteria. These criteria are to be used partly to judge whether a particular drug is in agreement with the general principals of priority in health care, and partly for valuation if the costs of using the drug are reasonable according to medical, humanitarian and socio-economic reasons. This means that cost-effectiveness shall always be considered in relation to the degree of ill-health. The claim for cost-effectiveness must always be higher for less serious states of health than for more serious illnesses.

At present (2007-01-02), there are guidelines for four groups of diseases and five more are in the process of being written.

In this work is a statement of cost-effectiveness ratios used. Less than 100,000 SKr per gained QALY are regarded as low costs in relation to health benefits, 100,000-500,000 SKr as moderate, 500,000-1,000,000 SKr as high, and above 1,000,000 SKr as very high costs in relation to health benefits.

Aim for public health

The government’s aim for public health [132] is to create the optimum conditions for good health for all, on equal conditions. Within the public health sector, there are eleven domains of targets with potential impact on great proportion of societal achievements. One of them is for the health care to promote good health. Health promotion and preventative view shall permeate the health care organization, and be a noticeable component of all care and treatment. The health care system has a key role in the public health work, with their particular competence, authority, greater knowledge of and contact with the population. For the health care system to focus on healthy living is to bring about a shift of opinion regarding which knowledge and ways of working are most effective in the prevention of ill health and promotion of healthy living in the long-term. Health care providers increasingly should use their authority, knowledge, and relationship with the population to promote good health both in meetings with patients and relatives, and by a systematic integration of health promotion and preventive aspects into current practices. Thus, they will be self-evident components in the whole chain of care. A health promotion and preventative direction increase the quality of care and are an important ingredient in making care more effective.

According to the proposition, health care is deficient in their responsibility for preventing ill-health by promoting positive lifestyles such as quitting smoking, less use of alcohol, better eating habits, increased physical activity, and the importance of relaxation and sleep. These habits are partly responsible for the unequal health between groups in the population. The preventative achievements are only 5% of all Swedish health care costs [133].

Another domain of targets is increased physical activity, and since this applies to the whole of society, it therefore also concerns the health care.
Conclusion

The Swedish Health and Medical Service Act state that the objective for health care is good health as well as preventing ill-health. The government’s decision regarding priority in health care states that preventative achievements have the same importance as other effective methods of treatment. Further, cost-effectiveness is an important aspect of priority in health care. Cost-effectiveness shall be considered in relation to the degree of ill health. Regarding the aims for public health, the role of promoting health is highlighted.
2. Aims

The overall aim of this thesis is investigating the cost-effectiveness of promoting physical activity in the health care system.

Specific aims are

• Provide a model for analyzing cost-effectiveness and equity in health for community-promoted physical activity.
• Review current knowledge about the cost-effectiveness of health care based interventions aimed at improving physical activity.
• Calculate cost-effectiveness of promoting physical activity as a treatment method in primary health care.
• Illustrate the importance of enjoyment of exercise in interventions aimed at promoting physical activity.
• Describe how time spent on exercise can be valued.
3. Materials and methods

3.1. Methods for developing an economic and equity analysis model

With aim to design an evaluation model, standard methods for economic evaluation of health care and health effects of physical activity respectively were studied. Methods for economic evaluation were adapted from Drummonds et al., "Methods for the Economic Evaluation of Health Care Programmes" [84]. Studies of the health effects of physical activity were modeled from "Physical Activity and Health; A Report of the Surgeon General" [10]. Where these works did not cover a specific topic, a Medline search for articles was done, and additional studies were retrieved from the reference lists of closely related articles.

A variety of interpretations of equity-in-health have been discussed in the academic literature. It is not self-evident what aspect of equity it is worthwhile to achieve. One well-known example is that persons in equal need should be treated the same. Mooney [134, 135] argues for equal access for equal need, and Culyer and Wagstaff [136] suggest equality of health itself. We have analyzed official Swedish documents [131, 132], and the Swedish policy is clear: equal access is a necessary, but not sufficient, objective. The official goal is equity in health. Based on common economic analysis models and policy of equity in health an analysis model was developed.
3.2. Review method of cost-effectiveness of health care based interventions

A search for articles published prior to or during December 2004 was done using Medline, SPORTDiscus, Database of Abstracts of Reviews of Effects, NHE Economic Evaluation Database, and Health Technology Assessment Database. A combination of "physical activity," "exercise," or "fitness," and "cost-benefit," "cost-effectiveness," "cost-utility" or "economic" were used as key words. In addition, reference lists were reviewed for other pertinent studies.

To be included in this study, the economic evaluation should consider both cost and health consequences. Other criteria were that promotion of physical activity was a major focus of the program and, the intervention was a task for health care. The study was a factual or modeled controlled study with at least six-month follow-up from beginning of the intervention. The aim of an intervention was sustained increase in physical activity. Use of physical activity only for a restricted time, like with physical therapy after an injury, was not included.

Evaluations of interventions found in the literature search are described using the following variables; intervention method, study design, main cost-effectiveness ratios and authors’ conclusion of cost-effectiveness level (acceptable etc.). Health economic analyses can be done with partly different methods, aims and perspectives. To increase the comparability, concerned aspects in the evaluations are compared with aspects considered in a model developed for economic evaluation of interventions to promote physical activity (see chapter 4.). Not considered aspects are summarized under the labels “improve cost-effectiveness” and “lessen cost-effectiveness”. Thus we make an analysis of the excluded components influence, and that will indicate if the ”true” cost-effectiveness is better or worse than the estimated ratios based on partial data. Omitted aspect’s consequence for the change direction is always obvious while the magnitude is unsure.
3.3. Analysis methods for a primary health care based trial

Materials

The calculation is based on two sources. The main source comprises data from a trial in Swedish primary health care, but use is also made of data from other economic evaluations of physical activity promotion in primary health care.

Trial in Swedish primary health care

Patients recruited to the study had sought primary health care, were at least 19 years old, and suffered from illness, which their GPs assessed as being treatable with physical activity. Common diseases were musculoskeletal pain and disorders, cardiovascular disease, diabetes, mental illness, and obesity. Two groups were recruited from among primary health care patients in Karlskoga. During 2001-2002, 199 individuals were recruited; the first 150 of these were invited to a follow-up in which 110 (73%) of them participated (study group 2001). In 2002-2004, a further 71 patients were recruited of which 64 (90%) participated in the twelve-month follow-up (study group 2003). A control group was created from among patients who sought primary health care in the neighboring and almost equally-sized Kristinehamn; this control group consisted of 47 patients of whom 44 (94%) took part in the follow-up (see Figure 2).

![Figure 2: Individuals in the study: invited, enrolled, and followed up.](image)
At baseline, there were no significant differences between the groups in age, BMI, medical problems, sick leave or exercise habits. There were significant higher proportion of female in the control group compared to study group 2003; 94% vs. 76% (p=0.01).

Patients in the intervention group were initially assessed by GPs in order to determine whether treatment with physical activity was appropriate given each patient’s individual illness. Patients deemed suitable were given information on the proposed physical activity, and each patient then decided whether or not to participate. Participating patients received an initial structured consultation about their health problems, lifestyle, and life situation, in which medical goals for the treatment outcome were set up. Three exercise sessions a week were planned, and patients were offered ten different kinds of group-based exercises during the daytime. The group exercises were performed under the supervision of medically-educated personnel, and also included motivational support. After three months, a further health and exercise consultation was made, in which future exercise was planned and goals were set up. Patients were given help with finding exercise opportunities in the town and designing exercise plans of their own.

The control group received ordinary primary health care, along with advice to exercise and information about local exercise opportunities. They also received the same follow-up as did the intervention group. Thus, the control for the study was a low-intensity promotion of physical activity, rather than complete absence of promotion of physical activity.

It should be noted that patients such as the participants in this study are often not healthy or fit enough to take advantage of the general physical activity options in their society.

Written informed consent was obtained from participants, and an ethics committee approved the study.

Other economic evaluations

The earlier-mentioned review of the cost-effectiveness of physical activity promotion in health care included three articles relevant to the present research question. Another recently published article, not included in the review, was also considered to be relevant. Although these economic evaluations either had a strictly preventive perspective or were focused solely on intermediate outcomes, they were all able to provide useful information for the calculation in the present article (see Table 2).
Table 2: Four economic evaluations of physical activity promotion in primary health care.

<table>
<thead>
<tr>
<th>Author, year, and country</th>
<th>Intervention</th>
<th>Study population</th>
<th>Design</th>
<th>Main cost-effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lindgren [137], 2003, Sweden.</td>
<td>Exercise advice and opportunity to join exercise groups with the aim of preventing CHD. No time limit. Compared to dietary advice and no intervention.</td>
<td>160 men aged 35-60 in a primary health care setting.</td>
<td>Randomized controlled study and data from other studies.</td>
<td>Dietary, SKr 127,000-142,000/life year saved. Exercise was almost as cost-effective (data not shown).</td>
</tr>
<tr>
<td>Stevens [138], 1998, UK.</td>
<td>Consultation with an exercise development officer, and the offer of a personalized 10-week program. Compared to no intervention.</td>
<td>714 inactive adults aged 45-74 years from two general practices.</td>
<td>Randomized controlled study.</td>
<td>Increasing an individual’s activity level (i) above sedentary, £650; (ii) to recommended level of physical activity, £2,500.</td>
</tr>
<tr>
<td>Sevick [139], 2000, USA</td>
<td>Behavioral skills training by group meetings. 6 month intensive and 18 month maintenance phase. Compared to structured exercise with supervised, centre-based exercise.</td>
<td>235 obese and sedentary adults, 35-60 years.</td>
<td>Randomized controlled study.</td>
<td>$22 (behavior skills) and $37 (exercise) per mL/kg/min increase in VO\textsuperscript{2} peak.</td>
</tr>
<tr>
<td>Dalziel [140], 2006, New Zealand</td>
<td>Verbal advice and written exercise prescription given by GPs, with telephone exercise specialist follow-up. Compared to usual care.</td>
<td>878 inactive patients presenting to New Zealand general practice.</td>
<td>Cluster randomized study and data from other studies.</td>
<td>$NZ2,053 per QALY gained over full life expectancy.</td>
</tr>
</tbody>
</table>

**Analytical methods**

The analysis is based on the model presented in 4.1.

The analysis in this study is a cost-utility analysis with a societal perspective [84, 141], using gained QALY as the measurement of effects. Cost-effectiveness ratios are based on the incremental health effects and costs for the intervention group compared to those for the control group.

Adherence to new physical activity is of great importance for cost-effectiveness. While there are existing reviews of adherence to new physical activity habits, none of them examine how long these new physical activity habits persist [70, 142, 143]. Hence, our calculation had to rely on assumptions of adherence.

All costs are shown in Swedish kronor at 2005 rates (1 USD = 7 SKr). Costs of the primary health care were calculated based on estimated time consumption, and estimated fractions of costs for care center rent, equipment, and overheads. The costs of increased physical activity were calculated based on the out-of-pocket expenses recorded by the participants before the start of the intervention, and before follow-up.

Participants compared time spent on exercise with time spent on paid work, household chores, and leisure activities. Costs were then estimated based on net wages in the ratio in which
the participants equalized time spent on exercise with time spent on paid work and household chores [112].

The cost-effectiveness calculation includes, besides the mean changes of HRQL for the merged study group, a smaller change of HRQL representing the lower end of the 95% confidence interval of change for the merged study groups. Participants who were not followed up were assumed to have unchanged physical activity levels (and subsequently unchanged HRQL and expenses for physical activity). Thus, results were calculated on an intention-to-treat basis.

All effects and changes in costs were assumed to occur from the start, and were discounted at 3% per year.

**Statistical analysis**

Analysis of statistical significance was performed using a t-test (paired within group) for parametric variables and a Wilcoxon matched-pairs signed-rank test for nonparametric variables.

**Measurements**

Measurements made at baseline and the follow-up at twelve months (14-30 months for study group 2001) were used in the calculation; see Table 3.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Variable</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population penetration</td>
<td>Proportion who participated</td>
<td>Proportion of referred patients who participated in exercise.</td>
</tr>
<tr>
<td>Adherence</td>
<td>Physical activity</td>
<td>Questionnaire measuring the previous month’s exercise in an ordinal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>way from ‘never’ to ‘more than five times a week’ [144, 145].</td>
</tr>
<tr>
<td>Treatment effect</td>
<td>Health-related quality of life</td>
<td>EQ-5D in combination with preference scores from a British population</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[146, 147].</td>
</tr>
<tr>
<td>Costs</td>
<td>Recruitment and program costs</td>
<td>Accounts of primary health care providers.</td>
</tr>
<tr>
<td></td>
<td>Participants’ expenses</td>
<td>Questionnaire measuring participants’ expenses over the previous week.</td>
</tr>
<tr>
<td>Time</td>
<td>Increased time spent on physical activity and</td>
<td>Changed time spent on exercise was estimated based on the</td>
</tr>
<tr>
<td></td>
<td>valuation of this time</td>
<td>questionnaires mentioned above, with the duration of an exercise</td>
</tr>
<tr>
<td></td>
<td></td>
<td>session assumed to be 45 minutes.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Questionnaire asking participants to rank the time spent on exercise</td>
</tr>
<tr>
<td></td>
<td></td>
<td>compared to paid work, household chores, and “pure enjoyment”.</td>
</tr>
<tr>
<td>Savings</td>
<td>Health care</td>
<td>Questionnaire asking participants about the last 6 months’ visits to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>health care providers (study group 2003 and the control group).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Primary health care records regarding the last 6 months’ visits to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>primary health care providers (study group 2001).</td>
</tr>
<tr>
<td></td>
<td>Sick leave</td>
<td>Questionnaire asking participants about the last 6 months’ sick leave,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>inclusive of early retirement pension (study group 2003 and the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>control group).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sick leave for longer than 14 days in the last 6 months as recorded at</td>
</tr>
<tr>
<td></td>
<td></td>
<td>regional social insurance administration (study group 2001).</td>
</tr>
</tbody>
</table>

Table 3: Measurement methods for variables in the health economic analysis.
3.4. Evaluation methods for analysis the impact of enjoyment of exercise

The purpose of this study was to investigate the importance of enjoyment of exercise in a health care-based intervention aimed at promoting physical activity in primary health care patients, and, more specifically, to explore the association between enjoyment of exercise and time spent on exercise, and between changed enjoyment and changed time spent on exercise. Differences between the study groups in changed enjoyment of exercise were also analyzed. Finally, associations between motivation for exercise (exercise for health or for enjoyment) and time spent on exercise were studied.

The same intervention as in paper III is analyzed, but only study group 2003 and the control group are included in the analysis.

Measurements

Time spent on exercise of medium- and high-intensity physical activity in the previous week was measured by the International Physical Activity Questionnaire (first edition) [148].

”Enjoyment” is here used as a possible mediator of PA. To our knowledge, neither a generally accepted definition of ”exercise enjoyment” nor a clear-cut validated measuring method has been established. ”Enjoyment” may be described as an affective state of positive feelings, such as pleasure, liking, and fun [4, 5]. In this study, ”enjoyment” is defined as the arising emotions that participants experienced during exercise. The definition may also cover aspects such as relaxation and pain reduction. Enjoyment of exercise was measured using a graphic rating scale (a modified Visual Analog Scale with discrete alternatives below the line), which has been evaluated and has been found to be superior to the Visual Analog Scale in order of consistency and stability [149]. Subjects were asked the question, ”How do you experience your exercise?”, and the scale started at ”entirely negative” and ended at “entirely positive”. A graphic rating scale also measured motivation for exercise with the endpoints ”only for health” and ”only for enjoyment”. Consequently, a positive value indicated that motivation in enjoyment overrode motivation in health, and vice versa. Health-related quality of life was measured using the European Quality of Life scale (EQ-5D) [150, 151].

Enjoyment of exercise, time spent on exercise, and motivation for exercise were measured at baseline, and after 3, 6, and 12 months. The baseline measurements were done after a first meeting with the district medical officer and after the intervention was presented to the participants. At baseline and after 12 months, HRQL and the body mass index (BMI) (weight in kg/m²) were also measured.

Analysis method and statistics

According to Lewis, studies of physical activity need to examine both the effect of an intervention on change in mediators at a later (follow-up) time point, and the impact of change in the mediators on physical activity behavior [77]. Baranowski et al. recommend that the role of mediators in intervention should be examined by specifying which mediators are the target of an intervention, which determines whether the intervention has successfully changed the targeted mediator, and evaluates whether change in mediators predict change in physical activity behavior [76]. The analysis in this paper will cover these aspects.
At the start of the study, enjoyment of exercise was difficult to measure because some of the participants were sedentary and did not perform any exercise. In other words, for these subjects, the proposed intervention was not yet self-experienced, and therefore, baseline measurements were a mix between experienced and expected enjoyment of exercise. Therefore, when the association between changed enjoyment of exercise and changed time spent on exercise was analyzed, the interval between 3 and 12 months was chosen. The following analysis methods were used:

Spearman's rank correlation was used to examine the association between enjoyment of exercise and time spent on exercise (at 12 months' follow-up), the association between changed enjoyment of exercise and changed time spent on exercise (between 3 and 12 months), and the association between motivation for exercise (health/enjoyment) and time spent on exercise. Both the association between motivation at baseline and motivation at 12 months' follow-up, and associations between motivation and time spent on exercise at 12 months' follow-up were calculated.

Differences in changed enjoyment of exercise between the intervention group and the control group were analyzed using the independent t-test, while changed enjoyment of exercise within the intervention group and the control group was analyzed using the paired t-test.
3.5. Methods for estimating costs of time spent on exercise

Exercise time can be defined as the time lost due to receiving care. We have followed the recommendation of the Washington Panel that only the time lost to receiving care should be monetarised, and productivity losses due to morbidity and impaired ability should be measured in terms of QoL [124]. Further, we have chosen to value the time lost to receiving care by a shadow price, using the opportunity cost approach [118], and consequently have valued the time spent on exercise based on this approach. As we can see, this is the only possible approach among the valuation approaches described in the previous section.

Before we proceed with a description of our methods, it is necessary to explain the concept of marginal costs, which are used in the calculation of the opportunity costs, and to discuss certain aspects of utility needs, which are relevant to the valuation of time spent on exercise.

**Marginal costs**

The opportunity costs of time are equal to the valuation of alternative activities during that time, because individuals actually value the time use rather than time as such [152]. Marginal value is key to this line of thinking. The marginal value of work is assumed to decrease; in principle, the first hour’s work of the day is the most valuable, while the last hour of working is least valuable. Similarly, the marginal costs of lost leisure time can be assumed to increase with working time, since if an individual sleeps for 8 hours then the constraint is about 16 hours to share between work and leisure. See Figure 3.

![Figure 3: Marginal value of work and marginal costs of lost leisure time. The arrow indicates the point at which the marginal value of work and the marginal costs of leisure time are equal.](image)

The individual is assumed to work up to the point at which the marginal value of work is equal to the marginal cost of leisure time [112] (see the arrow in Figure 3). In general, activities lost due to exercise are assumed to be the least valuable leisure activities, and hence their value is equal to the marginal value of work, and so can be represented by net wages [112].

**Utility**

The value of time is equal to the value of the utility an individual receives, and the difference in value between two activities can be regarded as the difference in individual utility [84]. Utility can be divided into two parts; utility during the performance of the activity (utility in use) and utility after the activity is performed (utility in anticipation) [12].
Work and leisure time are motivated by both utility in use and utility in anticipation. The choice between work and leisure is a choice between different mixtures of utility in use and utility in anticipation. When the marginal utility for work is the same as the marginal utility for leisure, the sum of utility in use and utility in anticipation is the same for work and leisure. However, there is certainly a greater amount of utility in anticipation for work than for leisure. Hence, when we choose work over leisure, we probably choose utility in anticipation (of work) and sacrifice utility in use (of the leisure activity).

**Definition of costs of time spent on exercise**

Utility in anticipation of exercise, and the possible losses of utility in anticipation for the activity foregone in favor of exercise, should be expressed in terms such as QALY [124]. Conversely, utility in use cannot be captured using health-related QoL measures, and so should be monetarised [124]. The costs and benefits for an individual of the time spent on exercise can be expressed as in Figure 4:

<table>
<thead>
<tr>
<th>Costs</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utility in anticipation of activity forgone expressed in QALY</td>
<td>Utility in anticipation of exercise expressed in QALY</td>
</tr>
<tr>
<td>Utility in use of activity forgone expressed in money</td>
<td>Utility in use of exercise expressed in money</td>
</tr>
</tbody>
</table>

*Figure 4: Costs and benefits of time spent on exercise.*

The monetarised cost of time is only a matter of utility in use. The following can be stated:

*The cost of time spent on exercise is the value of utility in use of leisure activity forgone minus the value of utility in use of exercise.*

**Estimation of costs**

In this analysis, the value of utility in use of the leisure activity forgone is estimated as the opportunity cost equal to the value of work on the margin. This is valid under the assumption that the leisure activity forgone comprised the least valuable leisure hours, and was motivated only by utility in use.

The method of valuing utility in use of exercise is based on the assumption that work (on the margin) represents a loss of utility in use compared to the least valued leisure hour, and that this difference is compensated by net wage. This implies that the utility in anticipation connected with the work is equal to the net wage, and that the utility in use connected with leisure time at the margin is equal to the net wage. We add two simplifying assumptions, that the net wages are the only utility in anticipation of working, and that the leisure activity forgone by taking exercise contains only utility in use.

These two anchoring points – utility in use of work at the margin, and utility in use of the leisure activity forgone in favor of exercise – can be used as a yardstick for the measurement of utility in use. The gap between these two points is equivalent to net wage.
Questionnaire

'Utility in use' is a technical term, which will not be correctly understood by people in general. A crucial issue was thus to find an easily understood term to cover utility in use, and only utility in use. Two notions were considered. 'Enjoyment' may cover many aspects of utility in use, but it does not include aspects such as pain reduction and well-being. 'Positive experience of time' may cover enjoyment, but also includes other aspects of utility in use. Experience of time was decided to best represent utility in use, and was supposed to not contain any utility in anticipation.

The respondents were asked to evaluate and mark their experiences of paid work, lost enjoyment activity, and exercise on a graphical rating scale. It was stressed that only the experiences while the activity was in progress should be judged. The options on the scale were assumed to be equidistant.

| purely negative | mostly negative | neutral | mostly positive | purely positive |

The questionnaire used in the investigation consists of three main parts: 1) identification of the leisure activity forgone, 2) rating of the experience of time spent on exercise, work, and the leisure activity forgone, and 3) collection of data regarding exercise habits and other background variables.

In estimating the costs of the time spent on exercise, the following interpretations were made:

1. When the experience of exercise was graded higher than or at the same level as the leisure activity forgone, the value of utility in use of exercise was the same as for the leisure activity forgone.
2. When the experience of exercise was graded lower than the activity forgone, and graded lower than or at the same level as work, the utility in use of exercise was zero.
3. When the experience of exercise was graded in between the experience of work and that of the leisure activity forgone, the value of the time spent on exercise was determined by its position on the scale relative to the positions of work and leisure activity.

Material

The investigation was performed in two different groups:

- experienced exercisers (inclusion criterion: had exercised at least once a week for two years or more, and were aged 20-65 years)
- inexperienced exercisers (inclusion criterion: had not exercised at least once a week for two years or more, and were aged 20-65 years)

These groups were chosen on the hypothesis that their time costs would differ, in order to indicate the costs of time both at the beginning of an intervention and in the long run. Invitations to participate were extended to the first 82 individuals who were encountered at an exercise centre, and the first 123 individuals who received exercise on prescription in two county councils.
The characteristics of the participants are presented in Table 4.

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Age in years</th>
<th>Proportion female</th>
<th>Proportion in work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experienced exercisers</td>
<td>164</td>
<td>50</td>
<td>87%</td>
<td>67%</td>
</tr>
<tr>
<td>Inexperienced exercisers</td>
<td>41</td>
<td>45</td>
<td>90%</td>
<td>68%</td>
</tr>
</tbody>
</table>

*Table 4: Characteristics of the participants.*

**Statistical analysis**

Analysis of statistical significance was performed using a paired samples t-test for parametric variables and a Wilcoxon matched-pairs signed-rank test for nonparametric variables.

Correlation between parametric variables was analyzed using Spearman's correlation coefficient.
4. Results

4.1. A model for analysis of community based interventions

Health economic and equity-in-health evaluation model

Methods to promote physical activity generate two main effects: health effect in the target group and economic consequences for the society. In addition, there are reasons to investigate the distribution effect, because costs, savings and health effect can differ between groups in the society.

The model proposed for cost-effectiveness analysis is shown in Figure 5. The left branch of the model shows factors crucial for a program's effectiveness. The main factors are exercise efficacy, population penetration (the capacity to recruit participants), and adherence to physical activity. Efforts can result in both treatment and prevention effects. The treatment effect is increased health and/or quality of life and can be measured by a HRQL instrument with a preference score. The prevention effect is decreased risk of future poor health and can be estimated by evaluating the changes in degree of activity or fitness and linking these to different risks for morbidity and mortality as documented in epidemiological studies. The health effect can be expressed as gained life years or QALY [84]. The follow-up period needs to be long enough for the participants to establish new habits [153, 154].

![Figure 5: Model for economic evaluation of methods to promote physical activity](image-url)

Cost effectiveness

Exercise efficacy

Population penetration

Adherence to physical activity

Treatment effect

Preventive effect

Health effect

Recruitment costs

Program costs

Participants’ time

Savings due to health effect

Net costs
Recruitment costs and program costs are mainly costs for information, personnel, equipment, and participants’ out-of-pocket-expenses during the program, and include health care costs due to injuries caused by physical activity. The largest resource is often the time spent by participants on physical activity. Savings due to effects on health are economic benefits for the participants and others. Net costs consist of recruitment and program costs, participants’ time, and savings. The effects of treatment and prevention, together with net costs, will be the determinants of the cost-effectiveness of the program and can be expressed as net savings or costs per gained QALY.

In model, the distribution of the treatment and prevention will be the determinants of the equity-in-health effect. Relevant socio-economic characteristics (e.g. income, education, occupation) and gender can be used to divide the population into subgroups. The health gains and cost-effectiveness calculations are presented for all subgroups. The suggested calculations result in a matrix with unique ratios for each subgroup. Population penetration (P) and QALY gained per participant (Qp) together generate QALY gained per individual in the equity group (Qe). By comparing Qe for an equity-in-health subgroup and Qe for the whole population, it can be seen whether there will be more or less equity-in-health in the population because of the intervention. In this example it is also possible to see the cost per gained QALY for each subgroup by evaluating the relationship between net cost per participant (C) and QALY gained per participant (Qp).

In this situation, the decision-makers have to decide whom to offer this type of intervention. It seems unlikely that in practice a pure health maximization rule will be applied since there are some studies showing that Swedish health care politicians reject pure maximization [155, 156]. The decisions are more likely to be an intuitive trade-off between equity and efficiency. This means that a higher cost per QALY may be preferred to a lower cost if the former is connected with a more desirable distributional profile. See Table 5.

<table>
<thead>
<tr>
<th>Subgroup 1</th>
<th>Subgroup 2</th>
<th>Subgroup 3</th>
<th>Subgroup 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population penetration (%)</td>
<td>P₁</td>
<td>P₂</td>
<td>P₃</td>
</tr>
<tr>
<td>QALY gained per participant</td>
<td>Q₁</td>
<td>Q₂</td>
<td>Q₃</td>
</tr>
<tr>
<td>QALY gained per individual in the subgroup</td>
<td>Q₁₁ = P₁ * Q₁</td>
<td>Q₂₂ = P₂ * Q₂</td>
<td>Q₃₃ = P₃ * Q₃</td>
</tr>
<tr>
<td>Equity effect</td>
<td>Q₁₁ / Qₑ₁</td>
<td>Q₂₂ / Qₑ₂</td>
<td>Q₃₃ / Qₑ₃</td>
</tr>
<tr>
<td>Net cost per participant</td>
<td>C₁</td>
<td>C₂</td>
<td>C₃</td>
</tr>
<tr>
<td>Cost per QALY</td>
<td>C₁ / Q₁</td>
<td>C₂ / Q₂</td>
<td>C₃ / Q₃</td>
</tr>
</tbody>
</table>

Table 5: Model for evaluation of changes of equity-in-health for methods to promote physical activity. P=Population penetration; Qp=QALY gained per participant; Qe=QALY gained per individual in the equity group; C=net cost per participant.
4.2. Cost-effectiveness of 26 health care based interventions

Twenty-six articles were identified, with intervention methods differing from brief advice to offering participation in exercise groups and help with behavior modification. In some studies, the promotion of other health-related behaviors was included. The intervention methods can be divided into the two main groups "exercise" and "advice". "Exercise" is when the study group is primarily offered the opportunity to join exercise groups. "Advice" is when the intervention is based on advice to the study group about exercise, sometimes in combination with education or support to change physical activity habits. Equally common are exercise, advice and a combination of the two.

The study interventions are always compared with an alternative intervention. In 4 of the 6 articles, the alternative is no intervention at all, or the same intervention without the promotion of physical activity. Two studies involved a comparison between two different programs to promote physical activity. The interventions involve different settings and different groups of participants, from healthy middle-aged people to people with heart failure or frail elderly. For the most part, people in the studied groups are sedentary. In many cases, the study population is drawn from a health care setting. According to the authors, 0 of the 6 interventions were cost-effective.

A complete economic analysis of the promotion of physical activity should consider all aspects in the presented model [157], however, a number of aspects that improve cost-effectiveness were not considered. Health effects are mostly incomplete. Not only are preventive or treatment effects omitted, but health effects after follow-up time and health effects for diseases other than those primarily prevented or treated are also omitted. Savings that are not considered are mostly with regard to production, but in eight articles, health care was also omitted. Aspects that lessen cost-effectiveness, such as the participants’ out-of-pocket-expenses and time, were not considered. Expenses were not considered in 18, and time was not considered in 20 of the articles.

In the following, five examples with relevance for Swedish health care are presented.

Primary health care based exercise advise in combination with exercise groups [137]

Setting
Patients in primary health care were screened for cardiovascular risk factors. Invitations to participate in the study were sent to 188 men aged 35-60 years, with subjective health and no history of cardiovascular disease, diabetes or other severe illness. 158 participated and were randomized into four groups – diet, exercise, diet + exercise and no intervention.

Intervention method
The intervention was aimed at reducing the risk of coronary heart disease (CHD). Subjects were given individual oral or written advice, and were offered participation in a free weekly lecture series, group sessions for stopping smoking, weight reduction, exercise or cooking classes.

Result
At the 6-month follow-up, participants in the exercise group had increased the number of exercise sessions per month from 5 to 12 (p<0.001). The control group had an unchanged 6 numbers of
exercise sessions per month. Based on changes in total cholesterol and diastolic blood pressure by use of a stochastic Markov model, a reduction in potential coronary heart disease events was predicted. Costs per life-year-gained were 180,000 SKr (year 2000).

Discussion
This evaluation showed that the intervention could be regarded as cost-effective [137], despite only considering the prevention of CHD. Still, the program effects on other diseases and treatment effect is not considered. Since this study was performed in a Swedish health care setting, the intervention obviously has great relevance for Swedish health care.

Preventing disability and managing chronic illness in frail older adults [158]

Setting
A senior centre in Seattle, USA, in collaboration with primary care providers of two large managed care organizations. A total of 201 chronically ill adult seniors aged 70 and older participated. Recruitment was through medical practices, randomized to intervention and control groups.

Intervention method
A target, multi-component disability prevention and disease self-management program was led by a geriatric nursing practitioner. Participants were encouraged to select from a menu of physical activities available at the senior centre that included walking, swimming, dancing, tai chi, and a supervised endurance, strength, and flexibility-training program. These were offered 3 times a week. Home exercise options were recommended for those who preferred not to participate in the group activities at the senior centre. In addition, participants received individual counseling by a nurse and the option to participate in a self-management course, of which 34% took part.

Result
The intervention led to significantly higher levels of physical activity and significant reduction in the use of psychoactive medications. The total number of inpatient hospital days during the study year was significantly less in the intervention group compared with controls (p=0.049). Savings in health care during the follow-up year were 4 times program costs.

Discussion
Interventions such as this, aimed at promoting physical activity in older adults in Sweden, would offer the potential for great gains in health and significant savings in the health care costs. This type of intervention would be appropriate for health care run both by county councils and local governments.

Cardiac rehabilitation [159]

Setting
Patients aged <65 years, with a myocardial infarction. Intervention group consisted of 147, and control group of 157 non-selected patients.
**Intervention method**

The intervention group participated in a rehabilitation program consisting of health education and physical training in out-patient groups, and follow up at clinic. The training groups started 6 weeks after myocardial infarction, and consisted of 45-minutes of endurance training sessions twice a week over a 3-month period. After initial training, the hospital-based sessions were phased out over a 2-year period, but patients were encouraged to continue with individual home training. The control group received standard care.

**Result**

On average, patients in the intervention group returned to work more frequently, which resulted in decreased costs due to loss of production. The mean total cost of a 5-year myocardial infarction follow-up was 73,500 SKr (1988) lower in the rehabilitated group. Savings in health care were 1.6 times costs, and together with productivity, savings were 17.4 times costs.

**Discussion**

The intervention was performed under Swedish health care. It is an old study, and the standard care that the control group received, has changed since 1988. Otherwise, it is a highly relevant study for Swedish health care today.

**Cardiac rehabilitation [160]**

**Setting**

Patients with acute myocardial infarction and mild-to-moderate anxiety or depression, or both, while still in hospital. 201 patients were randomized to either intervention or control group.

**Intervention method**

The intervention group received an 8-week exercise conditioning and behavioral counseling program. Weekly counseling sessions were given and participants attended 50-minute exercise session twice a week. The control group received standard care.

**Result**

During the first year, the intervention group gained 0.052 QALY more than the control group. Costs per gained QALY were $6,800 (1991). No gains after the first year were considered.

**Discussion**

The intervention is cost-effective and may be performed in the Swedish health care. It is an old study, and the standard care that the control group received, has changed since 1991. Otherwise, it is highly relevant study for Swedish health care of today.

**Diabetes prevention [161]**

**Setting**

Participants with impaired glucose tolerance were randomized to three groups, intensive program of lifestyle modification, metformin and placebo
**Intervention method**

Education aimed at weight reduction and increased moderate-intensity physical activity. Participants received a 16-lesson curriculum covering diet, exercise, and behavior modification, with an aim of 150 minutes brisk walking a week. The program lasted for 3 years.

**Result**

58% of the participants in the lifestyle intervention group were still physically active for 150 minutes a week at follow-up. Incidence of diabetes was 4.8 cases per 100 person-years in the lifestyle intervention group, 7.8 in the metformin group and 11.0 in the placebo group. Costs per gained QALY in the lifestyle intervention group compared to placebo were $27,100. The largest proportion of the costs consisted of supposed costs for participant's time spent on exercise and cooking. Cost-effectiveness only considers effects in prevention of diabetes, and any other diseases.

**Discussion**

The method can be regarded as cost-effective compared to many other efforts in health care, when all the health effects of the intervention are considered.
4.3. Cost-effectiveness of a primary health care based trial

290 patients were referred to study groups, and 93% of them participated in the prescribed exercise. The proportion of participants who exercised at least once a week increased from 51% to 74% in study group 2001, from 43% to 81% in study group 2003, and from 49% to 63% in the control group. These increases in activity were significant (p < 0.001) for the study groups, but their new level of physical activity was not significantly different from that of the control group (p = 0.18).

Dalziel assumed that the effect of the intervention decreased linearly over four years, while Lindgren presented two different assumptions: lifelong maintenance, and linear decrease back to the original levels over the two years after the second year.

We chose to make calculations for two scenarios. Firstly, increases in the participants’ physical activity (and subsequently HRQL) were assumed to be maintained for two years from the start of the program, and subsequently to decrease linearly to the initial level over the next three years. Secondly, the increases in activity were assumed to decrease linearly to the initial level over the two years after the one year follow-up.

The mean change of HRQL for the merged study groups was +0.093, and the lower end of the 95% confidence interval of change for the merged study groups was +0.050. The merged study groups had a significantly increased HRQL compared to the control group (p = 0.04). The preventive effect is omitted from the calculation.

Costs during the follow-up year were 3,700 SKr higher per patient for the study groups than for the control group.

Among study group 2003, the valuation of time spent on exercise decreased from 56% of net wages at start to 48% at follow-up (ns), while the valuation made by the control group increased from 46% to 60% (ns). From these figures, in combination with changes in the amount of time spent on exercise, and assuming an hourly net wage of 100 SKr (Statistics Sweden), it follows that the costs of time spent on exercise increased during the first year by 1,050 SKr for study group 2003 and 1,750 SKr for the control group. So in fact, the increase in costs was 700 SKr less in the study group than in the control group. This indicates that there were no major time costs for increased physical activity in the intervention group. Time costs were not covered by the four earlier articles, and are not considered further in the present calculation.

There were no significant changes in health care use and sick leave. The trial provided no evidence of savings. Although there will be savings of increased physical activity in the long run [59, 60, 162], the evidence of savings due to the treatment effect is scarce [107]. No savings were included in the calculation.

Costs per gained QALY were 18,090 SKr for the main alternative and 53,708 SKr for the less cost-effective alternative. See Table 6.
<table>
<thead>
<tr>
<th></th>
<th>First year</th>
<th>2 years full effect + 3 years decreasing</th>
<th>1 year full effect + 2 years decreasing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gained QALY, mean change</td>
<td>0.070</td>
<td>0.234</td>
<td>0.137</td>
</tr>
<tr>
<td>Gained QALY, lower end of 95% confidence interval for change</td>
<td>0.037</td>
<td>0.124</td>
<td>0.072</td>
</tr>
<tr>
<td>Program costs</td>
<td>+3350</td>
<td>+3350</td>
<td>+3350</td>
</tr>
<tr>
<td>Participants’ out-of-pocket expenses</td>
<td>+264</td>
<td>+883</td>
<td>+517</td>
</tr>
<tr>
<td>Net costs</td>
<td>3614</td>
<td>4233</td>
<td>3867</td>
</tr>
<tr>
<td>Net costs per gained QALY, mean change considered</td>
<td>18090</td>
<td>28226</td>
<td></td>
</tr>
<tr>
<td>Net costs per gained QALY, lower end of 95% confidence interval of change considered</td>
<td>34137</td>
<td>53708</td>
<td></td>
</tr>
</tbody>
</table>

Table 6: Costs per gained QALY for different assumptions of adherence and gained QALY. All costs in SKr. Not followed up participants were also considered.
4.4. The importance of enjoyment of exercise in interventions

In total, 115 patients (71 intervention subjects and 44 controls) were recruited from the two primary health care settings, and 101 completed both the baseline and the 12 months’ follow-up investigations. The mean age was 50 years (standard deviation = 8 years), and 86% were women.

Associations between enjoyment of exercise and time spent on exercise

There was a significant correlation between enjoyment of exercise and time spent on exercise at 12 months’ follow-up (r=0.35, p<0.01). The correlation seemed to be stronger for men than for women. Furthermore, BMI influenced this relationship. For non-obese participants (BMI<30), the correlation was stronger and significant, compared with obese participants (BMI ≥30), for whom a weaker and non-significant correlation was found. See Table 7.

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>r</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>All participants</td>
<td>101</td>
<td>0.35</td>
<td>0.00</td>
</tr>
<tr>
<td>Intervention group</td>
<td>61</td>
<td>0.32</td>
<td>0.01</td>
</tr>
<tr>
<td>Control group</td>
<td>40</td>
<td>0.40</td>
<td>0.01</td>
</tr>
<tr>
<td>Women</td>
<td>87</td>
<td>0.31</td>
<td>0.00</td>
</tr>
<tr>
<td>Men</td>
<td>14</td>
<td>0.73</td>
<td>0.00</td>
</tr>
<tr>
<td>BMI &lt;30</td>
<td>54</td>
<td>0.40</td>
<td>0.00</td>
</tr>
<tr>
<td>BMI ≥30</td>
<td>36</td>
<td>0.16</td>
<td>0.36</td>
</tr>
<tr>
<td>Age ≤44 yrs</td>
<td>30</td>
<td>0.33</td>
<td>0.08</td>
</tr>
<tr>
<td>Age 45–54 yrs</td>
<td>36</td>
<td>0.32</td>
<td>0.06</td>
</tr>
<tr>
<td>Age ≥55 yrs</td>
<td>35</td>
<td>0.42</td>
<td>0.01</td>
</tr>
<tr>
<td>HRQL ≤0.50</td>
<td>25</td>
<td>0.44</td>
<td>0.03</td>
</tr>
<tr>
<td>HRQL 0.51–0.79</td>
<td>47</td>
<td>0.22</td>
<td>0.14</td>
</tr>
<tr>
<td>HRQL ≥0.80</td>
<td>28</td>
<td>0.45</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Table 7. Spearman’s rank correlation between time spent on exercise and enjoyment of exercise for all participants in the two study groups, and in subgroups according to sex, body mass index (BMI), age, and health-related quality of life (HRQL).

Associations between changed enjoyment and changes in time spent on exercise

A significant positive correlation was found between changed enjoyment of exercise and changes in time spent on exercise for the whole study group (r=0.21, p<0.05). The correlation seemed to differ between the sexes, with men revealing a stronger correlation than women. Body mass index also seemed to have an impact on the correlation. For those with BMI <30, the association was significant, but there was no correlation for those with BMI ≥30. Age also influenced the correlation, as there was a strong correlation for participants ≤44 years old, but no correlation for those who were ≥45 years of age. See Table 8.
<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>r</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>All participants</td>
<td>98</td>
<td>0.21</td>
<td>0.05</td>
</tr>
<tr>
<td>Intervention group</td>
<td>60</td>
<td>0.21</td>
<td>0.11</td>
</tr>
<tr>
<td>Control group</td>
<td>38</td>
<td>0.18</td>
<td>0.29</td>
</tr>
<tr>
<td>Women</td>
<td>84</td>
<td>0.18</td>
<td>0.10</td>
</tr>
<tr>
<td>Men</td>
<td>14</td>
<td>0.44</td>
<td>0.12</td>
</tr>
<tr>
<td>BMI &lt;30</td>
<td>55</td>
<td>0.28</td>
<td>0.04</td>
</tr>
<tr>
<td>BMI ≥30</td>
<td>41</td>
<td>0.07</td>
<td>0.65</td>
</tr>
<tr>
<td>Age ≤44 yrs</td>
<td>29</td>
<td>0.57</td>
<td>0.00</td>
</tr>
<tr>
<td>Age 45–54 yrs</td>
<td>36</td>
<td>-0.06</td>
<td>0.72</td>
</tr>
<tr>
<td>Age ≥55 yrs</td>
<td>33</td>
<td>0.10</td>
<td>0.60</td>
</tr>
<tr>
<td>HRQL ≤0.50</td>
<td>29</td>
<td>0.22</td>
<td>0.26</td>
</tr>
<tr>
<td>HRQL 0.51–0.79</td>
<td>50</td>
<td>0.32</td>
<td>0.03</td>
</tr>
<tr>
<td>HRQL ≥0.80</td>
<td>19</td>
<td>-0.05</td>
<td>0.84</td>
</tr>
</tbody>
</table>

Table 8. Spearman’s rank correlation between a change in time spent on exercise and changed enjoyment of exercise for all participants in the two study groups, and in subgroups according to sex, body mass index (BMI) at baseline, age, and health-related quality of life (HRQL) at baseline.

**Changed enjoyment of exercise in a physical activity intervention**

The expected enjoyment of exercise at baseline was higher in the intervention group (with a score of 70.3) than in the control group (with a score of 62.4) (p<0.05). At the end of the intervention (i.e., at 3 months), the expected enjoyment of exercise had increased to an experienced enjoyment scoring 79.1 (p<0.01) in the intervention group. The highest rating was scored at 3 months, and by the 6 months’ follow-up, enjoyment had decreased to 71.8 (p<0.01). In the control group, there was no significant change over time. At the 12 months’ follow-up, the enjoyment of exercise was 25% higher in the intervention group than in the control group (p<0.01).

**Association between motivation for exercise and time spent on exercise**

There was no significant correlation between motivation (in health/enjoyment) for exercise at baseline and time spent on exercise at the 12 months’ follow-up. However, motivation at 12 months’ follow-up and time spent on exercise at 12 months were significantly correlated for all participants together (r=0.35, p<0.01). This positive association indicates that participants who were more motivated by enjoyment than by health spent more time on exercise than participants who were more motivated by health. When separately analyzing subgroups, the correlation tended to be stronger in the control group, in subgroups of individuals who were non-obese (BMI <30), ≥55 years old, and at baseline rated their HRQL as low.
4.5. Costs of time spent on exercise

When asked which activities they would give up in order to increase their exercise time, 6% of the group of experienced exercisers stated that they intended to forego work, 45% that they intended to forego housework, and 49% that they intended to forego enjoyable leisure activities. In the group of inexperienced exercisers, the answers were 7%, 25%, and 68% respectively.

The participants were also asked what kind of enjoyment they intended to sacrifice for one extra hour’s exercise a week: 90% of the experienced exercisers and 95% of the inexperienced exercisers stated that they would give up watching TV, videos, and other such media.

Among experienced exercisers, the estimated costs of the time spent on exercise came to 7% of net wages; the corresponding figure among the inexperienced exercisers was 26% of net wages (p<0.001). See Table 9.

<table>
<thead>
<tr>
<th></th>
<th>Experienced exercisers</th>
<th>Inexperienced exercisers</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>164</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>Cost of time (as percentage of wages)</td>
<td>7.2%</td>
<td>26.3%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Rating of the experience of foregone enjoyable activity</td>
<td>70.3</td>
<td>69.1</td>
<td>0.74</td>
</tr>
<tr>
<td>Rating of the experience of work</td>
<td>75.1</td>
<td>68.7</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Rating of the experience of exercise</td>
<td>87.2</td>
<td>71.5</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Table 9: Estimation of costs of time spent on exercise, expressed as percentage of wages. Ratings of the experience of foregone enjoyable activity, work, and exercise on a scale from 0 (purely negative) to 100 (purely positive).

When the two study groups were merged, the cost of the time spent on exercise was correlated (Spearman correlation coefficient) with a more positive experience of lost enjoyment activity (r=0.25, p<0.001), and a less positive experience of exercise (r=-0.45, p<0.001). However, there was no significant correlation with experience of work (r=0.00, p=0.96). Hence, higher time costs can be explained by a more positive experience of the lost enjoyment activity and a less positive experience of exercise.

Furthermore, the cost of time was correlated with the frequency (r=-0.18, p<0.01) and duration of regular exercise (r=-0.18, p<0.01).
5. Discussion

5.1. Better analysis of interventions is possible

Principal findings

An economic evaluation model was developed, and methods for measuring changes in equity in health were proposed.

The proposed model covers a greater number of aspects than were found in the reviewed evaluations. The two most important factors in the cost-effectiveness of community-promoted physical activity are probably adherence and the valuation of time. The degree to which these are favorable can be assumed to depend on the same thing – how much the participants enjoy the activity. Little is known about what determines an individual’s adherence to a new activity, but enjoyment of the activity may have great importance. When an individual enjoys an activity, the costs of lost leisure time are lower. On the other hand, it is not important for health gain that the activity be very intense. Therefore, an intervention that may be seen as less effective from a physiological perspective can be more cost-effective if it is more enjoyable.

It is known that socioeconomic factors are determinants for physical activity. An intervention with a general population as the target group will probably create physical activity among those who find it easiest to take up exercise; since these may be people with high education and good health, an intervention in a general population may increase inequity in health. Thus, if one objective is to increase equity in health, an intervention should address the disadvantaged subgroups of the population.

Strengths and weaknesses of the study

In this study, we identified the critical factors, which influence the cost-effectiveness of physical activity promotion; these factors include adherence to the treatment, the large amount of patient time used, and the fact that both treatment and preventive effect occur in the same intervention. These factors are not common, or are considered to be of less importance, in standard economic evaluations of health care treatment methods. Of additional interest from a public health point of view is the distribution of effects due to an intervention, and so we also developed a model to measure changed equity in health. Economic and equity analysis based on this model may improve the quality of evaluations compared to earlier published work.

The evaluation model does not cover every aspect of interest for participants; it is limited to health effects related to illness, and ignores other health effects such as well-being in general, better function above disability level, and aesthetic considerations.

If equity analysis is performed for small subgroups, the sample size must be rather extensive.

Strengths and weaknesses in relation to other studies

Drummond et al. have developed a checklist for assessing economic evaluations, covering ten different aspects of evaluations. The scope is general, not specific to the evaluation of physical activity promotion. One aspect is whether costs and consequences can be valued creditably; our proposed model can be seen as a development of the way that costs and consequences are
valued. Other aspects of interest, not specific to the promotion of physical activity, are omitted from the proposed model (for instance, discounting of future costs and consequences). Hence, for a complete analysis of an intervention promoting physical activity, the proposed model and the checklist of Drummond et al. should be used together.

**Meaning of the study**

The proposed model can be used to compare the cost-effectiveness and equity in health of different programs for physical activity promotion, and to compare physical activity promotion with competing treatment methods.

A number of health care based trials aimed at increasing physical activity in the population are currently in progress. Sweden’s National Institute of Public Health has developed a program, which prescribes physical activity, and many trials using this model are ongoing. However, there is a need for further evaluations of the cost-effectiveness of physical activity used as a health promotion method.

**Unanswered questions and future research**

Although it is obvious that economic evaluation of community-promoted physical activity is possible, there is still a need for methods for accurate evaluation. In the proposed model for evaluation, several improvements will make the evaluations more reliable and informative. Greater knowledge is needed about the long-term effects of sustained adherence to new physical activity habits. Furthermore, in measuring changes in HRQL, there is a need for methods that are more sensitive to those aspects influenced by physical activity. Indexes such as EQ-5D [151] were not developed with the aim of measuring changes in HRQL due to changes in physical activity habits, and are not sensitive to small changes in quality of life. Most of the people in a general population already have the highest value of physical or mental function at baseline, and so the indexes are best suited for evaluation of progress in the rehabilitation process within a population with illness.

There is uncertainty in the measurement of physical activity. Methods need to be developed to value the time spent on physical activity. We also need more knowledge of how equity in health should be valued in comparison to cost-effectiveness; it is more a question of normative rather than positive economics. Thus far, it has been shown that Swedish politicians believe there should be a trade-off between health maximization and equity in health [164]. In general, Swedish people think it is worthwhile to sacrifice health for equity in health [165, 166].
5.2. Physical activity promotion in health care is cost-effective in many cases

Principal findings
This review found examples of cost-effective interventions consisting of advice, some types of behavior modification, and exercise, as well as combinations of these interventions. There is a lack of evidence for the cost-effectiveness of interventions aimed at those whose only risk factor for illness is a sedentary lifestyle. There is more evidence, although it is limited, of the cost-effectiveness of interventions aimed at high-risk groups or those who manifest poor health related to physical inactivity. Most evidence for the cost-effectiveness of physical activity is among older people and those with heart failure.

Health gains are underestimated in all the articles analyzed, but the magnitude of the underestimation is uncertain. Savings are also underestimated in most of the articles. On the other hand, estimations of costs are also incomplete, and there is a particular lack of estimates of the value of participants’ time. Keeping in mind these shortcomings, this review found good examples of cost-effective interventions based on advice, some types of behavior modification, exercise, and combinations of these. However, it remains impossible to rank the cost-effectiveness of one kind of intervention compared to another. The evidence for the cost-effectiveness of physical activity promotion can be summarized in three main population groups. Interventions in a general population may be cost-effective, but there is still scarce evidence. There is some evidence of cost-effectiveness in an older population, and among patients with heart failure; however, the four studies regarding patients with heart failure suffer from design shortcomings. It may be cost-effective to promote physical activity among high-risk groups or those manifesting poor health related to physical inactivity. The preventive effect is probably enough to motivate an intervention among these groups, and the treatment effect for people with poor health can be considerable.

Strengths and weaknesses of the study
This was the first general review of the cost-effectiveness of promotion of physical activity in health care. The different studies were conducted in different ways, and so it was difficult to draw conclusions. Despite these differences, the review did produce new knowledge regarding cost-effectiveness. More precise conclusions will require better methods for economic evaluation of the promotion of physical activity.

Cost-effectiveness is relative, and can differ across nations. In this review, the statements of the authors of each article were used to judge whether the interventions were cost-effective. In the Swedish context, this is not an appropriate method, since the border of acceptable cost-effectiveness ratios according to the guidelines of the National Board of Health and Welfare (see chapter 1.7) may be higher than that used in most of the articles.

Strengths and weaknesses in relation to other studies
No other such review articles have been published. A recent article regarding the cost-utility of the Green Prescription Program in New Zealand did identify nine cost-effectiveness and cost-utility analyses [140], but these studies were not analyzed further because the review was only intended to provide background information for the article.
Meaning of the study
The efficacy of the promotion of physical activity is well known for many ill-health situations, but there is scarce knowledge of its cost-effectiveness. Hence, physical activity is probably not used in health care as much as it actually merits. This study summarizes current knowledge regarding cost-effectiveness.

Unanswered questions and future research
Promotion of physical activity can be cost-effective, but there is too little evidence to draw conclusions as to which methods, and which groups of patients, maximize the cost-effectiveness. There is a need for more studies, of better design. There is also a lack of information regarding situations where physical activity should not be used.
5.3. Treating with physical activity promotion in primary health care may be cost-effective

Principal findings

Physical activity used as a treatment method in primary health care, alongside standard care, among a general population of patients with medical problems due to physical inactivity, is probably cost-effective. The costs per gained QALY are rather low, even in the least favorable scenario.

There is a large body of evidence that intervention in health care can increase physical activity among patients. In the present trial, physical activity increased significantly not only in the study groups, but also in the control group, and much more so than the slight trend in the surrounding society [167]. In general, the literature discusses only the amount and intensity of physical activity. For the actual patient group, 93% of whom have musculoskeletal problems, the type of physical activity is also of great importance. The activity needs to have a treatment effect on the actual problems, rather than simply increasing the energy consumption of the participants.

Increased physical activity may result in decreased costs for health care and sick leave [66, 107]. In this limited study it was not possible to show preventive effects, and potential savings from these effects were omitted from the cost-effectiveness analysis. Hence, the actual cost-effectiveness is probably even better than calculated here.

The intervention method seemed not to suit men. It is probable that this is because the types of activities, and their occurring in the daytime, did not suit most of the men in the target group.

Strengths and weaknesses of the study

For the most part, our calculation relied on results from a single trial; however, data from other trials was included regarding population penetration, adherence, and costs. The use of data from several interventions makes it more likely that the calculation of cost-effectiveness is generalisable to other settings.

The trial employed a controlled study design, but was not a RCT. When the study was planned, the project had already existed for three years and had influenced both the supply of and the demand for exercise opportunities in the town. Study design problems like this are common in effectiveness studies, a phenomenon particularly notable in comparison to efficacy studies [125, 168, 169]. Effectiveness studies of therapies already shown to be efficacious need not necessarily be RCT [126], and many cost-effectiveness analyses regarding promotion of physical activity are based on non-randomized controlled trials [107].

During the study, a design problem was revealed. The GPs for the control group were not as familiar with seeing the possibilities of using physical activity as a treatment method for serious ill patients as the GPs for the study group. Hence, at the beginning they had difficulties finding similar patients to the study group.

The study and control groups were originally planned to consist of 100 women and 100 men each, but the final study and control groups consisted only of a third of these. The county council mainly supported the study, but grants for the study were cut due to reorganization within the county council. The study was therefore stopped before half of the proposed study time had passed due to a lack of funding.
Time spent on physical activity was measured with a valid method, the International Physical Activity Questionnaire (IPAQ) [148], which measures activity over the previous week. However, there was a gap between the participants’ first meeting with the staff and the baseline measurements of physical activity, and the participants were likely more active during this time than before the first meeting with the staff. Hence, the baseline measurement was not done at the very beginning of the intervention. Instead, a measurement considering the previous month’s physical activity was used in the analysis. This method of measuring is widespread in Sweden, often used for evaluating the life-style and health of individuals [144, 145], but it is not validated for research use.

During the study, the participants’ valued time spent on exercise. Earlier studies have only done assumptions of time costs. However, the method of time valuation needed further development.

A great deal of research has been conducted on adherence to physical activity in general, but no research was found on adherence to increased physical activity levels due to an intervention. Hence, the basis for assumptions about future adherence is weak. The chosen assumption may be regarded as conservative. The low level is similar to the follow-up time, and the high level is only around twice of the longest followed up time (22 months). Therefore, calculated effects related to adherence to new physical activity habits may not be exaggerated, and larger effects may exist in reality.

The main strength of the calculation is that it is based on a trial performed in ordinary practice and on patients representative of the population of interest.

**Strengths and weaknesses in relation to other studies**

There is still a lack of knowledge regarding the types of patients who can be successfully encouraged to exercise. Previous economic evaluations, with a preventive perspective, have evaluated physical activity promotion among patients with fewer health problems than the patient group considered in the present study. Hence, our calculation of cost-effectiveness among more seriously ill patients provides additional knowledge about the possibility of promoting physical activity.

We have shown that the time spent on exercise does not create any major costs in this target group. Previous studies have either ignored this aspect, or based their estimation of time costs on assumption with no empirical input.

**Meaning of the study**

The evaluation shows that physical activity can be promoted among patients with serious health problems cost-effectively. Promotion can also be done for patients that do not have sufficient health or fitness to participate in the general physical activity options in society. If health care is to help those who have the greatest need for treatment by increased physical activity, they need to be involved in the performance of exercise activities.

**Unanswered questions and future research**

Our calculation is mainly based on one of many possible intervention methods, and on physically inactive patients in primary health care in general. There is a need for additional economic evaluations, focusing on different methods of promoting physical activity and different patient groups.
5.4. Enhanced enjoyment of exercise has impact on effectiveness of interventions

Principal findings
In the investigated group of patients, enjoyment of exercise was associated with time spent on exercise. There were associations between enjoyment and exercise time, as well as between changes in enjoyment and changes in exercise time. Furthermore, our study revealed that health care-based interventions could increase enjoyment of exercise. Probably, it is important to motivate yourself with health gains when starting to exercise; however, there was no correlation between motivation (in health/enjoyment) at the study start and time spent on exercise 1 year later. We conclude that for long-term effectiveness, health care-based interventions need to address enjoyment of exercise in order to promote physical activity.

Enjoyment of exercise may be more important for men's physical activity than for women's physical activity. Furthermore, the association between enjoyment and physical activity seemed to be stronger in non-obese people. In conclusion, the importance of enjoyment of exercise in promoting physical activity differed substantially between subgroups.

The intervention group's enjoyment was 25% higher than that of the control group at 12 months' follow-up. This indicates that the 3-month intervention program did have long-term effects on enjoyment of exercise. The control group had an almost unchanged enjoyment during the whole study period. It seems possible to enhance enjoyment of exercise for a long time after a time-limited intervention.

There was no correlation between motivational factors among the patients at study start and time spent on exercise at 12 months' follow-up. This indicates that the motivation of improved health at the study start may not have had any impact on time spent on exercise in the long run. However, enjoyment as a motivation for physical activity at 12 months' follow-up was correlated to more time spent on exercise. In health care, it is common to promote physical activity by giving health gains as a motivation for change. However, these methods seem to be effective only if patients enjoy the exercise.

Strengths and weaknesses of the study
The study was performed in an everyday clinical practice and the participants were ordinary patients with common illnesses. The results may therefore have clinical relevance. In this study, the effect of an intervention on change in the target mediator at follow-up, and the impact of change in the mediator on physical activity behavior are presented in accordance with Lewis's and Baranowski et al.'s recommendations [76, 77]. Baron and Kenny have recommended an additional test of mediators [170]. This test was not possible to conduct due to not significant differences between study and control groups in time spent on physical activity.

No validated questionnaire for measuring enjoyment of exercise in a patient group was found in the literature. A questionnaire called the "Physical Activity Enjoyment Scale (PACE)" has been validated for use among adolescent girls [171], but was not suitable for the targeted group of this investigation.
In subgroup analyses, the different correlations between enjoyment and exercise time indicated presence of possible confounding factors. Maybe other mediators, such as self-efficacy and social support, impacted on both enjoyment and exercise time. Enjoyment can influence self-efficacy [80], and then again, self-efficacy may influence enjoyment. To our knowledge, the possible impact of social support on enjoyment has not been reported.

Strengths and weaknesses in relation to other studies

Three previous studies have not been able to show sustainable and significant influence on enjoyment of exercise, as reviewed in Lewis et al. [77]. However, Dishman et al. recently showed that increase in enjoyment partially mediated increased physical activity in high school girls [80]. In a review of exercise prescriptions for older people, it was concluded that focus should be shifted from motivation and behavior change per se towards satisfaction and enjoyment [82]. The results of our study support this conclusion.

Meaning of the study

Health care often uses health gains to motivate patients to increase their physical activity. This may be important at the start of a program, but does not seem to have an impact on adherence to exercise in the long run. If promotion of physical activity in health care is to have effects on health, long-term adherence to exercise has to be achieved. Making exercise more enjoyable is one way to achieve this goal.

Unanswered questions and future research

This trial was conducted in a small patient group, and indicates that enjoyment of exercise may be a topic of interest for future research. More knowledge from studies in larger patient groups is needed.

Enjoyment was important for adherence to exercise in this group of patients, but knowledge of what makes exercise enjoyable is scarce. Is it the possibility of choosing an activity or of meeting with people in group exercise, or does the exercise in itself cause the enjoyment? Alternatively, is enjoyment linked to how the group is led? These questions remain to be answered by future studies.
5.5. Costs of time spent on exercise are important for cost-effectiveness

Principal findings
Economic theories support the valuation of leisure activity forgone. A model for this valuation was proposed and tested in two groups of exercisers. The costs of the time spent on exercise were significantly higher among inexperienced exercisers than experienced exercisers; this was due to higher valuation of lost leisure time and lower valuation of the time spent on exercise.

Work time (on the margin) was assumed to represent a loss of utility in use compensated by net wages, and leisure activity (on the margin) to represent no loss of utility in use. The reality is less simple. The participants seemed to enjoy their work, and many participants enjoyed their leisure activity (on the margin) less than their work. Two situations dominated the valuation. In the first, the experience of exercise was valued more highly than both lost enjoyment activity and work, and hence no net cost was accounted. In the second, the experience of exercise was valued less highly than both lost enjoyment activity and work; in this case, exercise time was accounted as costs equivalent to net wages. In the group of experienced exercisers, the experience of exercise was valued more highly than the lost enjoyment activity (87 vs. 70, p<0.001), so these individuals in fact have benefits in utility in use besides the utility in anticipation.

Strengths and weaknesses of the study
The model delivers the costs of time spent on exercise as valued by the participants. The questionnaire is easy to administer, and can be used to evaluate interventions in large study groups.

A critical part of the model is the comparison with the activity forgone. This activity needs to be the least valuable leisure time activity and motivated only by utility in use; while the activity may include some utility in anticipation, this utility must not motivate the activity. Thus, the utility in use of this activity represents the marginal value of leisure time. The most common activity forgone was watching television, videos, and other such media, with 90% and 95%, respectively, in the two groups, stating that they would give up this activity in favor of exercise. While this activity might have some informational or knowledge value, the degree of utility in anticipation may be low and is probably not any motivator of the activity. Hence, the utility in use of the activity forgone in the investigation may represent the marginal value of leisure time.

Estimation of the opportunity costs of time is based on particular circumstances. Individuals must be able to regulate their working time, and a working labor market without any unemployment is supposed. In reality, the basis for the estimation of costs is different. It is common for individuals to be unable to change their working time; and there are also situations where there is no lack of leisure time, and hence the marginal value of leisure time is less than the marginal value of work. Although the assumptions are not realistic, the net wage rate nevertheless forms an upper bound estimate of the opportunity cost of work time at the margin. The opportunity cost of leisure is relevant in valuing the loss of non-working time, both for the employed and for those not currently working [112]. The present investigation has shown that, on the margin, people do not always value utility in use of leisure time more highly than utility in use of work. The theoretical foundation of the marginal value of work and leisure time may be criticized as
being inappropriate, but in this case it can at least be stated that costs of exercise time are not underestimated.

Evaluations, which make use of rating scales, should specify whether the data are cardinal or just ordinal. In many cases, like the present one, the points on the scale are supposed to be equidistant, and hence the data are cardinal. Other common use of rating scales as cardinal are when calculating QALY from rating scales [84] and from the EQ-5D visual analogue scale [151].

The questionnaire must be validated, which means that the following must be ascertained:
1. Correlation between the theoretical definition and the operational indicator; in this case, between ‘utility in use’ and ‘experience’ (of exercise, work, and enjoyable activity forgone).
2. No systematic bias. In the present investigation, this is a question of whether the costs of the time spent on exercise are correctly measured and calculated.
3. Whether it is possible to generalize the results to the target population.

A common way to validate the first two aspects is to compare the received result with a "gold standard", that is, something which is already accepted as being correct. In this case, it is hard to find a gold standard. The most reasonable standard to compare with is the amount of exercise taken by each individual, based on the assumption that lower time costs should result in higher net utility of exercise, and hence more exercise. However, other aspects, such as individual’s different preference of good health, may also influence the amount of exercise.

The third aspect of validation is not relevant to this investigation. The chosen populations were not intended to produce generalisability results, but simply to show that the model was capable of capturing the expected difference between experienced and inexperienced exercisers. The correlations between the net costs of time spent on exercise and the frequency and duration of regular exercise were significant, and the directionality was as expected.

In one way or another, our experience of something is always influenced by the utility in anticipation. When we know that something is good for our health, we certainly enjoy the activity more. The utility in anticipation will increase the utility in use, but the utility in anticipation per se (i.e. the expected health gain) is not accounted for in our model for valuation of time.

**Strengths and weaknesses in relation to other studies**

A recent review found six articles which included the costs of the time spent on exercise [107]. Hatziaandreu was the first to discuss the costs of the time spent on exercise. He assumed that time costs were equivalent to net wages for those who disliked exercise, half net wages for those who were neutral, and zero for those who enjoyed exercise [172]. Jones assumed that the time costs for those who disliked the activity were equivalent to half net wages [173]. Georgiou assumed full gross wages for all exercise time [174], while Levin assumed 35% of gross wages for all exercise time [159], and Johannesson counted 35% of gross wages as costs for spare time used for health care visits, but ignored the costs of exercise time [175]. Finally, the Diabetes Prevention Group used 50% of gross wages for those who disliked exercise and 25% for those who were neutral [161].

The costs of exercise time for investigated inexperienced exercisers seem to be around a quarter of net wages, which is generally only a little lower than the assumptions made in previous studies. However, the long-term costs seem to be much lower than these assumptions, and so valuations based on Hatziaandreu’s assumption require rethinking.
Meaning of the study
In cost-effectiveness analysis with a societal perspective, it is important to consider the costs of the time spent on exercise, particularly when methods of treating medical problems with medicine or other therapies are compared to methods based on patient time, such as promotion of physical activity.

The individual's time costs are of great importance when promoting sustainable increase of physical activity. In the individual's cost-benefit ratio for performing physical activity, the time costs can be large, and it is important to lower them if sustainable increases of the level of physical activity are to be achieved. Also for this reason, it is of interest to follow the time costs of the participants in an intervention.

Unanswered questions and future research
This is the first attempt to value the time spent on exercise, and should not be seen as the final solution. The next step is to use the model and questionnaire in an economic analysis of the promotion of physical activity. Experience from this practical use may open up the possibility of developing the method further. It may also be possible to adapt the method to the public health area of healthier eating habits.
5.6. Main findings

The main findings are presented according to the aims of the thesis.

Overall aim

Investigating the cost-effectiveness of promoting physical activity in health care. There are many examples of interventions promoting physical activity that may be regarded as cost-effective. In general, promoting physical activity among patients with increased risk or who manifest poor health associated with physical inactivity seems to be cost-effective. Unfortunately, there is still little evidence of when physical activity should be used, or what the best design of an intervention might be.

Adherence to new physical activity habits is of great importance in the effectiveness of an intervention. Adherence is correlated to the enjoyment of exercise, which is also the cost of time spent on exercise. For greatest value and cost-effectiveness, interventions therefore ought to promote the enjoyment of exercise.

Specific aims

Provide a model for analyzing cost-effectiveness and equity in health for community-promoted physical activity. An economic evaluation model is developed, and methods for measuring changes in equity in health are proposed. If these are used, the decision makers will receive more complete information for decision.

Review current knowledge about the cost-effectiveness of health care based interventions aimed at improving physical activity. Some examples of cost-effective interventions consist of advice or counseling, some type of behavior modification, and exercise, as well as a combination of these interventions. Evidence is lacking for the cost-effectiveness of interventions aimed at those whose only risk factor for illness is a sedentary lifestyle. There is more evidence, although limited, of the cost-effectiveness of interventions aimed at high-risk groups or those which manifest poor health related to physical inactivity. Most evidence for cost-effectiveness relates to physical activity for older people and those with heart failure.

Calculate cost-effectiveness of promoting physical activity as a treatment method in primary health care. The intervention was cost-effective, and promoting physical activity used as treatment in primary health care can be cost-effective.

Illustrate the importance of enjoyment of exercise in interventions aimed at promoting physical activity. In the invested group of patients, enjoyment of exercise was associated with time spent on exercise. An intervention can ultimately have an impact on the participant’s enjoyment of exercise.
Describe how time spent on exercise may be valued.
A method for the valuation of time spent on exercise is proposed and tested in two exercise groups. Costs of time spent on exercise appear to be higher among the inexperienced when compared to experienced exercisers. This valuation method seems to be a far better way to estimate time costs in economic evaluations than the assumptions used in earlier economic evaluations.
5.7. Consideration of methods used

Several problems in methodology have been identified in the five papers in this thesis. Here, they are discussed in both general and specific terms.

Measuring physical activity

In the evaluation of the promotion of physical activity, there are problems with measurements of physical activity. All physical activity is of interest, but measurements are complicated and expensive to conduct. In evaluations of promoting physical activity, the intermediate effect (changed physical activity habits) and endpoint effect (health and HRQL gains) need to correlate. Otherwise, it is not shown that the physical activity is the cause of the endpoint effect. Hence, the quality of the measurement of changes in physical activity is of great importance.

Methods of measuring physical activity can be divided into objective and self-reported approaches. Common objective methods include use of heart rate monitors (counting heart beats), pedometers (counting steps), accelerometers (counting steps in combination with intensity), and cardio respiratory fitness testing. Other methods are also used. Self-reported methods generally include the maintenance of a physical activity diary, recall questions and questionnaires. There are several validated self-reporting methods, such as the IPAQ questionnaire used in paper III and IV. All methods have both strengths and weaknesses in their ability to measure physical activity, and the capacity to be performed in evaluation situations without bias. A question of specific interest is the influence of method on the investigated individual’s physical activity during the studied period. However, examination of these problems of measurement is beyond the scope of this thesis.

Measuring HRQL

A measurement of HRQL must be adapted to assess aspects of quality of life related to physical activity and sensitive enough to catch smaller changes. Of specific interest are smaller changes in well-being.

EQ-5D is an easily-managed instrument for measuring HRQL and is often used as a foundation for the calculation of QALY [151]. Typically, the EQ-5D questionnaire is used in combination with a preference score for each health state. The scoring system was developed in the United Kingdom [150]. The five questions describe basic functions, pain and anxiety, but no other aspects of physical activity. Consequently, the questionnaire can only be used for people with significant health problems, and does not cover effects such as well-being, fitness above disability level and aesthetics. The total impact of the intervention in Paper III on HRQL may be greater than EQ-5D is able to measure.

Comparing different health economic studies

There is a rapidly growing amount of cost-effectiveness analyses, but evaluation methods are not uniform. Over time, methods of evaluation have been changed. Hence, there are considerable problems in comparing the assessed cost-effectiveness between studies: different analysis methods have been used, the perspective may differ, settings are not the same, the comparison with current practice is different and the components of costs and benefits are given different consideration. Several guidelines have been developed and one of the most important may be the "WHO guide
to cost-effectiveness analysis”, which aims to provide guidelines for maximizing the applicability of results across settings [105]. However, it is still difficult to compare health economic analysis due to large differences in evaluation methods.

A popular checklist for assessing the quality of economic analyses is that presented by Drummond et al. [84]. This checklist has a far wider scope than the analysis model proposed in paper I. The model proposed in this thesis should not be seen as an alternative to the checklist, but something that can work together with the checklist to increase the quality of assessment for some specific questions, particularly in relation to the promotion of physical activity. The proposed model emphasizes aspects of specific interest for promoting physical activity, and will not provide comprehensive results if used as the sole means of assessment for a study.

The 26 assessed economic evaluations of promoting physical activity showed a large variability in the methods used to evaluate and measure physical activity, health effects and savings. Therefore, the proposed analysis model may work as a foundation for assessment of considered aspects in evaluations. The arguments suggesting the cost-effectiveness of promoting physical activity in health care are weak, due to shortcomings in the evaluation methods in the found 26 articles. It was of interest to rank the interventions according to cost-effectiveness ratios, but the variability and shortcomings in methods made it impossible. A tentative judgment has been attempted regarding a complementary addition of aspects not considered in the assessed evaluations, but too many weak assumptions will make a calculation of cost-effectiveness inaccurate.

Study design

Chapter 1.6 examines study designs, and a crucial concern raised is how to determine whether the use of RCT is inappropriate.

In paper III, the study design was not a RCT. When the study commenced, the project had already been running for three years. During that time, the intervention had gradually evolved to the final design, and cooperation with exercise companies had been established. The period had also resulted in GPs becoming more experienced regarding when physical activity should be prescribed as a treatment. The project was well-known to citizens and among societal institutions. Under these circumstances, it was deemed impossible to conduct a RCT without significant bias or ethical conflicts. The main reasons for not running a RCT were:

- Patients had been asked to participate in the project. It should be unethical to then not prescribe physical activity in that situation.
- GPs at the health care centre had increased their frequency of prescribing physical activity during the project, were discussing physical activity habits with patients and exercise on prescription was common. There was risk of contamination, if GPs had been expected to provide care in two different ways.
- As a part of the project, new exercise opportunities for people with ill-health had been developed. These opportunities were also open to participants from outside the intervention group and could create bias in a RCT.

Dropouts

Dropouts are a problem in many studies, but possibly to a greater extent in effectiveness studies. The main reasons are twofold. Long-term adherence to new physical activity habits is an
important aspect, and therefore, the study should follow the participants for a long period of time. Unfortunately, the dropout rate in long-term studies is inherently high. The promotion of physical activity creates participants with increased physical activity levels, but also creates a fraction that not have managed to increase their physical activity level. Those who not have been physically active may not be motivated to take part in follow-up activities.

The dropouts in the study in Paper III are all believed not to have increased their physical activity and health related quality of life. It can be even worse. An adverse effect of even less physical activity compared to before the start of the project, as a consequence of the intervention, is also possible. However, most of the participants were sedentary or close to sedentary before the participation in the project. The increase in physical activity levels is probably lower among the dropouts, but lack of success in increasing physical activity may not be the only reason that participants withdraw from the study. Some of them may have been successful, but have had neither the opportunity for, nor interest in, participating in a follow-up session.
5.8. The need for further research

In general, there are too few cost-effectiveness evaluations of existing methods of promoting physical activity in health care. More research is needed regarding the most cost-effective methods for each patient group.

Most existing intervention methods may be targeted at increasing patient motivation to perform physical activity. Additional research of other methods for promoting physical activity is needed. Promising methods seldom used in the health care, include strengthening self-efficacy for physical activity, strengthening the social support for performing physical activity and efforts to making physical activity more enjoyable.

In this thesis, the enjoyment of exercise has been shown to be associated with the amount of time spent on exercise. More research is needed to establish enjoyment as a mediator for exercise participation amongst health care patients. Furthermore, enjoyment appears to be of differing importance between groups. Consequently, further research is also needed to determine which factors make exercise more enjoyable, whether it is the opportunity to choose an activity, meeting other people in a group exercise setting, the exercise in itself or the influence of a group leader’s personality.

Additionally, there is a need for comparisons between cost-effective analysis methods, with the aim of ranking intervention methods in terms of cost-effectiveness. These comparisons are only possible under conditions of concordance of evaluations methods. More research is needed to determine how interventions aimed at promoting physical activity should be evaluated economically.

One aspect of developing economic evaluation methods is determining precisely how time spent on exercise should be estimated and investigated. The first trial, as outlined in this thesis, need to be developed further.
6. Policy conclusions in the Swedish context

This chapter concerns policy conclusions for Swedish health care. There are at least three important questions to consider in a discussion of how policy should be changed in relation to new knowledge of the cost-effectiveness of physical activity promotion:

- How should promotion of physical activity in health care be economically evaluated?
- For which groups of patients should health care promote physical activity?
- How should health care promote physical activity?

6.1. How should promotion of physical activity in health care be economically evaluated?

Paper I presents a model for evaluating the promotion of physical activity from a societal perspective. However, it is still necessary to ask whether Swedish health care should have a societal perspective or some other perspective; which costs and effects should be significant in policy making, and which should be left to the individual? Thus, we must consider which benefits and costs are relevant for decision makers in the Swedish health care system. Two possible normative viewpoints on this question are the welfarist framework and the extra-welfarist framework (see chapter 1.6.2). However, the Swedish Health and Medical Services Act is also highly relevant, and must be taken into consideration (see chapter 1.7).

The welfarist framework is based on the assumption of each individual’s maximization of utility. From this view, all costs and benefits should be included. However, the situation regarding the extra-welfarist framework is less clear; the framework emphasizes health, but there are many different definitions of health. In this chapter, the WHO definition of health is used: “Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” [7]. The Health and Medical Services Act [129] states that health and medical services are aimed at assuring the entire population of good health and care on equal terms. Furthermore, care should be provided with respect for the equal dignity of all human beings. It should be noted that the term “health and medical services” is used in the act to refer to measures for medical prevention, investigation, and treatment of disease and injuries. Thus, according to the act, health-related activities other than the treatment and prevention of disease and injuries are not a task for the health care system.

Cost-effectiveness analyses of interventions in health care usually have a societal perspective. However, each health care authority has a restricted budget, and costs and benefits cannot usually be easily exchanged between different authorities within a society. An intervention can be cost-effective from a societal view, but not for the health care provider, so the perspective of the health care provider is also of interest when evaluating interventions and discussing priorities in the health care sector.

Table 10 presents cost-effectiveness aspects of health care promoted physical activity, and notes whether they are considered important in different viewpoints. Health benefits are divided into four different groups, all of which are influenced by physical activity: (i) less disease and injury, (ii) well-being, (iii) capacity, and (iv) aesthetics. Less disease and injury is a matter of both prevention and treatment; well-being is mostly concerned with health effects above the level of remaining
free from disease and injury; capacity describes one’s physical and mental function; and aesthetics covers health-related aspects of aesthetics, such as being lean and fit (if desired).

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Table 10: Benefits, costs, and equity considered according to the welfarist framework, the extra-welfarist framework (from both a societal view and the health care provider’s view), and the Health and Medical Services Act. Aspects marked with ‘+’ must be considered, those marked with ‘-’ must not be considered, and the situation for those unmarked is not prescribed.

1) The extra-welfarist framework emphasizes health. Savings and costs other than those for health care are of interest only if they have an impact on the individual’s health.

There are significant differences between the WHO definition of health and that of the commission for the health care system according to the Health and Medical Services Act. In general, the act does not have a societal perspective. Cost-effectiveness aspects not covered by the Health and Medical Services Act can be of great importance for societal costs and the individual’s quality of life [107]. The importance of well-being, capacity, and aesthetics as individual motivators for being physically active has not yet been investigated, but may for many be as important as remaining disease- and injury-free. Costs and savings for other than the health care have been shown to be significant [107].

The aspects of cost-effectiveness covered by the Health and Medical Services Act can be seen as compulsory in a cost-effectiveness analysis, while other aspects can be seen as optional. Hence, an analysis should be divided into compulsory aspects and other aspects of interest. The latter category will also include savings in production; although the Health and Medical Services Act
states that such savings should not be a foundation for prioritization between patients and efforts, they still hold an interest for society.

**Compulsory aspects**

Less disease and injury
Savings for health care
Costs for health care
Equity in health

**Other aspects of interest**

Well-being
Function
Capacity
Aesthetics
Savings for patients
Savings in production
Savings for others
Costs for patients
Costs of patients’ time
Costs for others

These two models for cost-effectiveness analyses, with different views, should be seen as complementary information for the decision maker.
6.2. For which groups of patients should health care promote physical activity?

The cost-effectiveness of the promotion of physical activity will be different in different groups of patients (and individuals who are not yet patients). In which of these groups will such promotion be cost-effective enough to be included in the restricted budget of the health care system?

Current knowledge about cost-effectiveness is summarized in chapter 5.6; however, this knowledge is not necessarily concordant with the Health and Medical Services Act and other prioritization rules. The studies reviewed in paper II mostly contain components, which are ’compulsory’ in the sense defined in chapter 6.1. If the ’other aspects of interest’ described in chapter 6.1 are also taken into account, the cost-effectiveness will change. However, it is difficult to estimate the general consequences for cost-effectiveness if all of these aspects are taken into account; the cost-effectiveness will be higher for some interventions and lower for others.

There is a need for stronger arguments for the cost-effectiveness of the promotion of physical activity in health care. Keeping this in mind, the following are recommended as tasks for the health care system when only compulsory aspects are taken into account:

- The promotion of physical activity as prevention in groups manifesting an increased risk of ill health (for instance high blood pressure) due to a physically inactive lifestyle. The benefit has mostly been demonstrated for prevention of heart disease, and this preventive effect alone is enough to motivate an intervention, but other diseases such as diabetes, metabolic syndrome, cancer, and depression will also be prevented.
- The promotion of physical activity among frail older people, especially those with increased risk of fall injuries.
- The promotion of physical activity as rehabilitation after heart failure.

The following factors will change when other aspects of interest are also taken into account:

- In groups who manifest increased risk of ill health, the cost-effectiveness may be somewhat lessened due to participants’ costs; however, these interventions will probably still be sufficiently cost-effective.
- The promotion of physical activity as prevention among older people in general will be more cost-effective due to increased savings among sectors other than health care. It is possible that this should always be a task for the health care system, but evidence is scarce.

The following may be tasks for the health care system, but have not been sufficiently evaluated:

- The promotion of physical activity as treatment of diseases and problems due to a sedentary lifestyle.
- The promotion of physical activity as prevention in groups of sedentary individuals without manifest increased risk of ill health.
6.3. How should health care promote physical activity?

The review of cost-effective methods (paper II) showed that different methods for promoting physical activity can be cost-effective. It is obvious that there is no single method that is preferable for all situations and groups of patients; neither the health problems due to physical inactivity nor the patients in the health care system are homogeneous. The promotion of physical activity should be different for patients in rehabilitation after a myocardial infarction compared to, for example, frail older people, or generally healthy young adults with slightly increased blood pressure. Hence, it is important that the health care system has different promotion methods at its disposal.

A single analysis of the cost-effectiveness of a particular intervention method cannot be generalized to other patient groups. Thus, it is not possible to rank the cost-effectiveness of methods aimed at promoting physical activity without considering the patient group in which they should be used. In addition, ranking within a patient group is also difficult, due to the scarcity of comparable cost-effectiveness analyses. A discussion of preferable methods can only be principal.

From an economic point of view, it can be stated that individuals increase their physical activity as long as the perceived benefits are larger than the perceived costs. The benefits are mainly anticipated utility (health gains), and can be of two kinds. Firstly, there are the health gains which appear in the short term, such as well-being and reduced pain; these benefits are referred to in the following discussion as factual health gains, because they are secured for the individual a short time after the performance of physical activity. Secondly, there are the health gains, which are uncertain for the individual even in the long run, such as reduced risk of disease; these benefits are referred to in the following discussion as expected health gains. The costs are out-of-pocket expenses, such as clothes and fees, and time costs. Because there is a decreasing marginal benefit (in health gains) and increasing marginal costs (in opportunity costs) in being physically active, there is a level of physical activity where costs and benefits are the same; the individual is supposed to be physically active at this level. The costs and benefits for the individual are shown in Figure 6.

<table>
<thead>
<tr>
<th>Costs</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out-of-pocket expenses</td>
<td>Factual health gains</td>
</tr>
<tr>
<td>Time costs</td>
<td>Expected health gains</td>
</tr>
</tbody>
</table>

*Figure 6: Costs and benefits for an individual of being physically active.*

An intervention aimed at promoting physical activity deals with an individual’s perception of benefits and costs, and should make it more favorable to be physically active. There are endless possible interventions, but they can all be divided into four major groups of methods:

1. Interventions aimed at increasing factual health gains
2. Interventions aimed at increasing expected health gains
3. Interventions aimed at decreasing (subsidizing) out-of-pocket expenses
4. Interventions aimed at decreasing time costs (increasing the enjoyment of exercise)
Most people experience factual health gains. They are probably already a reason for performing physical activity, and are probably already within the individual’s calculation of the costs and benefits of being physically active. Factual health gains will be difficult to increase unless there exist more effective methods of exercise that have not yet been tried. Interventions aimed at increasing individuals’ factual health gains will generally not work.

Increasing the expected health gains is a possible method for those individuals who lack knowledge about the relationship between physical activity and health. Better knowledge can increase the incentives for being physically active. It is probable that while most of the population knows that physical activity is beneficial to health, they are unaware of the extent of the benefits of being physically active. Hence, this method will work for most individuals.

Out-of-pocket expenses can be decreased by means of subsidies. This decrease in costs will make it more favorable for the individual to be physically active. There will be no major impact on the society’s costs (other than some additional administrative costs), only a change in where the costs are manifested.

Time costs can be decreased via increased enjoyment of exercise, and hence reduced net costs of time. This can be managed in different ways, such as by providing support to individuals in finding suitable exercise opportunities, by providing education in exercising, or by creating enjoyable exercise opportunities.

In summary, there are three categories of effective interventions: those which increase expected health gains, those which decrease out-of-pocket expenses, and those which decrease time costs. The following example presents the costs and benefits of exercise for an individual before an intervention, and subsequently, the imagined costs and benefits for the three effective interventions. Suppose an individual’s perceived costs and benefits for spending one additional hour on exercise are as follows prior to an intervention:

<table>
<thead>
<tr>
<th>Category</th>
<th>Monetary Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>out-of-pocket expenses</td>
<td>4</td>
</tr>
<tr>
<td>time costs</td>
<td>4</td>
</tr>
<tr>
<td>factual health gains</td>
<td>-3</td>
</tr>
<tr>
<td>expected health gains</td>
<td>-3</td>
</tr>
</tbody>
</table>

The costs are 2 monetary units higher than the benefits, and hence the individual will not spend one more hour on exercise. Assume further that the society has reasons to intervene, for instance because the individuals have incomplete information, and/or that external effects through collectively financed health care are present. An intervention with the aim of increasing the expected health gains can work if the value of the expected health gains increases by 2 monetary units; the benefits of spending one additional hour on exercise will then be the same as the costs. Interventions with decreased (subsidized) out-of-pocket expenses or decreased time costs will work when the costs are reduced with 2 monetary units. These examples are presented in table 11.
All three interventions will give the same result – one more hour spent on physical activity – since for the individual they have the same net balance of costs and benefits. The most cost-effective method is then the one with the lowest net costs for the health care provider or the society as a whole.

Interventions which decrease time costs have an advantage over the other principal intervention methods by working due to decreased costs for the participants, and hence for the society. The other two principal intervention methods have unchanged costs. Consequently, methods based on decreased time costs have a double effect on cost-effectiveness ratios, since they produce health gains from exercise as well as directly decreasing costs. Interventions aimed at decreased time costs (i.e. increased enjoyment of exercise) have great possibilities for being cost-effective; however, our knowledge is still insufficient to rank any method in front of another.
7. Conclusions

In general, the promotion of physical activity among patients with increased risk or manifest poor health associated with physical inactivity seems to be cost-effective compared to standard care.

There is still little evidence of what the best design of an intervention might be. Different groups of patients need different methods of promoting physical activity.

We have developed a model for the economic evaluation of the promotion of physical activity from a societal point of view, and proposed methods for measuring changes in equity in health.

An important aspect of sustainable increase of physical activity and cost-effectiveness is the ability of the intervention to create enjoyable physical activity. This emphasizes the need for health care to be involved in the design of the performance of physical activity.

In the process of creating the economic evaluation model, a need was identified for a method for valuing the time spent on exercise. We have proposed such a method, and used it to investigate time costs in two exercise groups. The cost of the time spent on exercise appears to be higher among inexperienced exercisers than among their more experienced counterparts.

Although there is still a need for stronger evidence, the Swedish health care system should use the promotion of physical activity as a standard method among the following patients:

- those who manifest increased risk of ill health (for instance high blood pressure) due to a physically inactive lifestyle;
- frail older people, especially those with increased risk of fall injuries;
- those requiring rehabilitation after heart failure.

Promoting physical activity among the following patients may also be a task for the Swedish health care system, but more economic evaluations are needed:

- older people in general;
- patients with diseases and problems due to a sedentary life style, and a need for treatment/rehabilitation;
- sedentary individuals without manifest increased risk of ill health.
References


