General introduction

Chapter 1
1. **Introduction**

In Western society, older adults form a population segment that is growing in numbers as well as in age. In 2004, the mean percentage of people over age 65 in Europe and the Netherlands was 17% vs. 14%, respectively. Although the Netherlands demonstrate a lower mean percentage of older adults compared with other European countries, this percentage will increase by 50% by the year 2025. The mean age of the older adults is also still growing. From 1980 to 2004, life expectancy after the age of 65 has developed from 15.53 to 18.36 and 16.51 to 18.37 years in Europe and the Netherlands, respectively.

With this in mind, reducing and postponing disability, diseases and the functional loss that accompany aging is an essential public health goal in which physical activity can play an important role. Scientific evidence demonstrates that participation in regular exercise programs can reduce or prevent a number of functional declines associated with aging. Older adults are trainable and able to adapt to endurance as well as strength training. Endurance training can result in maintaining or improving various aspects of cardiovascular function (e.g. VO\(_2\)max, cardiac output) as well as enhancing submaximal performance. Strength training can help offset the loss in muscle mass and strength associated with normal aging.

Health status can also be improved through a reduction in risk factors associated with disease states (e.g. cardiovascular disease, non-insulin dependent diabetes mellitus, hypertension, colon cancer, obesity, etc.), thereby increasing life expectancy. Additional benefits of regular exercise include improvement of bone health and thus a reduced risk of osteoporosis, stability and risk of falling, and an increase in flexibility. Finally, regular exercise also seems to provide a number of psychological benefits related to preserved cognitive function and alleviation of depression symptoms and behavior. In conclusion, the benefits associated with regular exercise and physical activity contribute to a more healthy lifestyle, improving the functional capacity and quality of life of older adults.

Despite all these benefits, many older adults are still sedentary or underactive. At the start of the development of the Groningen Active Living Model (GALM) in the late 1990s, actual data with respect to physical inactivity among older adults was scarce. Depending on the measurement methods used, physical inactivity percentages varied between 35 and 80% of Dutch older adults.
1.1 Physical activity, fitness and health

A conceptual model that illustrates the interrelatedness between physical activity, fitness and health is described by Bouchard and Shephard et al. (1994) (Figure 1). In this model the three key concepts are physical activity, health-related fitness and health. Physical activity is defined as "any body movement produced by skeletal muscles that results in a substantial increase over the resting energy expenditure." It covers leisure-time physical activity, occupational physical activity, and household and other cores (e.g. nursing relatives).

With respect to fitness, no universal definition is available. In present-day Western societies fitness is operationalized with a focus on two goals: performance and health. Performance-based refers to those components of fitness that are necessary for optimal work or sports performance. Regarding older adults, performance-based fitness refers to components necessary to optimally perform activities of daily living. Performance-based fitness depends heavily on motor skills, cardiorespiratory power and capacity, muscular strength, power or endurance, body size, body composition, motivation and nutritional status.

Figure 1. The Bouchard model.
Health-related fitness is about those fitness components that are affected favorably or unfavorably by habitual physical activity and relate to health status. Important components of health-related fitness include morphological (e.g. body composition, flexibility), muscular (e.g. power, strength, endurance), motor (e.g. balance, coordination), cardiorespiratory (e.g. maximum aerobic capacity, lung function) and metabolic aspects (e.g. glucose tolerance, insulin sensitivity). Pate (1988) defined health-related fitness as: a) the ability to perform daily activities with vigor; b) demonstration of traits and capacities associated with low risk of premature development of inactivity-related diseases. 

From the aforementioned definitions of performance-based and health-related fitness, a major point of criticism of the Bouchard model appears. Within the Bouchard model there is a lack of clarity with respect to the distinction between both aspects of fitness, performance vs. health-related. This overlap, together with the fact that performance-based as well as health-related components of fitness play an important role in older adults’ functioning and performance in daily living, makes both components relevant to be assessed in this study. In the progress of this thesis the terms performance-based fitness and health indicators will be used referring to performance and health focus within fitness, respectively.

Health is defined as a condition with physical, social and psychological dimensions, each characterized on a continuum with positive and negative poles. Health includes measures of wellness (positive health), as well as morbidity and mortality (negative health). The Bouchard model summarizes the interrelationships that appear between physical activity, fitness and health. Other factors (lifestyle, e.g. smoking, diet; personal attributes, e.g. age, gender; physical environment, e.g. temperature, altitude; social environment, e.g. political, economic circumstances) and heredity also influence the three key concepts and their interrelationships.

From the perspective of public health, the Bouchard model shows that physical activity, by influencing fitness, can influence health and vice versa. An independent mutual link is also possible between physical activity and health, regardless of fitness. In this thesis the relationships between physical activity and health-related as well as performance-based fitness measures will be studied.

In the following section the focus will lie on these two relationships by briefly describing the development of the physical activity recommendations for health and/or fitness in older adults.
1.2 Physical activity recommendations for improving fitness and health in older adults

Recommendations on quantity and quality of physical activity necessary to improve fitness and health differ. Major general recommendations on fitness and health were published in 1990, 1995 and 1998 by the American College of Sports Medicine (ACSM) together with the Centers for Disease Control (CDC).\textsuperscript{5,10-12}

The 1990 ACSM recommendations on the enhancement of fitness can be considered as the most commonly accepted standard.\textsuperscript{10} These guidelines focused on developing and maintaining cardiorespiratory and muscular fitness in healthy adults. The guidelines recommend an exercise training frequency of 3-5 sessions per week, a training intensity of 60-90\% of heart rate maximum (equivalent to 50-85\% of maximum oxygen uptake or heart rate reserve), a duration of 20-60 minutes per session, and rhythmical and aerobic use of large muscle groups. To develop and maintain muscular strength and endurance, moderate-intensity resistance training (one set of 8-12 repetitions of 8-10 different exercises at least twice a week) is suggested. Besides these guidelines, which focus primarily on cardiorespiratory and muscular fitness, they also recognized the potential health benefits of more frequent regular exercise at lower intensity for longer duration, independently of cardiorespiratory fitness. The 1990 recommendations stated that levels of physical activity lower than recommended may reduce the risk for certain chronic disease states without improving cardiorespiratory fitness (e.g. maximum oxygen uptake).

In 1995 the ASCM together with the CDC published new recommendations in addition to the 1990 ACSM recommendations in which a shift occurred that led to a primary focus on the link between physical activity and health-related benefits instead of the development and maintenance of cardiorespiratory and muscular fitness.\textsuperscript{11} The 1995 guidelines recommended that all adults perform 30 minutes of physical activity of moderate intensity (e.g. brisk walking) on most, preferably all days of the week. These 30 minutes could be covered in one 30-minute session or accumulated throughout the day in multiple bouts of 8-10 minutes. It was also acknowledged that, for most people, greater health benefits can be obtained by performing physical activity of more vigorous intensity and longer duration.

In 1998, besides the recommendations for adults,\textsuperscript{12} the ACSM published specific recommendations for older adults.\textsuperscript{5} These guidelines recognized that in addition to the health benefits of physical activity that are important for
all adults, important objectives especially for older adults are maintaining and improving cardiorespiratory fitness and the ability to perform activities of daily living independently and thus quality of life. Therefore it was stated that physical activity programs for older adults should focus not only on improving or maintaining health but also on improving cardiorespiratory fitness, strength, coordination and flexibility. To reach these objectives, in order to enhance not only health but also the cardiorespiratory fitness and the ability to perform daily activities independently, the 1998 recommendations promote physical activities of longer duration and higher intensity than recommended by the 1995 ACSM/CDC guidelines. Based on the 1995 and 1998 recommendations, a Dutch recommendation entitled *de Nederlandse Norm voor Gezond Bewegen* (NNGB), was developed in 1998.\(^\text{13}\)

1.3 **Effects of multi-modal/multi-component/multi-dimensional physical activity programs for older adults**

From the aforementioned recommendations it can be concluded that physical activity programs for older adults should pay attention to several components of fitness (cardiorespiratory, strength, coordination and flexibility). Such programs can be characterized as multi-modal/multi-component/multi-dimensional programs. Compared with the number of studies reporting on the effects of uni- or bi-dimensional exercise-based physical activity (training) programs, evidence on multi-modal physical activity programs remains scarce. These multi-modal programs can be characterized by simultaneously prescribed doses and intensities of strength, aerobic and balance training, and are feasible and capable of eliciting changes in physical functioning and quality of life.

Baker et al. (2007) conducted a systematic review on the effects of multi-modal exercise programs for older adults, and in the end included 15 studies that satisfied the following inclusion criteria: a) only randomized controlled trials; b) only involving studies with older adults with a mean age over 60 years; c) studies with single clinical diagnosis as entry criterion (e.g. stroke, multiple sclerosis, etc.) were excluded; d) the exercise intervention should at least contain three modalities of strength/resistance training, aerobic/cardiovascular endurance training and balance/stability training, and might include flexibility exercises.\(^\text{14}\)

Five studies administered home-based interventions and the others had supervised centre-based programs in class format of small groups.
Two studies had a combination of home- and centre-based exercise. The mean intervention duration was 8.8 (± 3.6) months with a range of 3-12 months. The general frequency of exercise was 3 days per week, with one study reporting a frequency of twice and one study once per week. Most commonly the control groups received no treatment, advice or other control activities (e.g. low intensity/flexibility exercises, education, nurse visit, etc.). The overall results suggest that multi-modal exercise has a positive effect on fall prevention. The limited data available suggested that multi-modal exercise may have a smaller effect on physical, functional and quality of life outcomes than single-modality programs. Aerobic fitness was only reported in one study and the direct measure of VO\textsubscript{2} demonstrated a significant effect of training on aerobic fitness. Despite this limited evidence of multi-modal exercise, it may be seen as an effective treatment in fall prevention but further investigation was recommended.\textsuperscript{14}

1.4 The Groningen Active Living Model (GALM)

The increase in number and age of older adults, together with the aforementioned role that physical activity can play in enhancing health and fitness, led to the development of a new strategy that aimed at stimulating leisure-time physical activity in sedentary and underactive older adults entitled the Groningen Active Living Model (GALM). After the development and pilot phase of GALM, the strategy was described in a manual and implemented from 1997 untill now in the Netherlands.\textsuperscript{15,16} Furthermore, five projects have been started in Belgium and based on the principles of GALM the Canberra Active Living Model (CALM) was successfully implemented in Australia.\textsuperscript{17}

GALM is a behavioral change strategy and is based on a process model in which behavioral change is seen as a multi-dimensional and dynamic process.\textsuperscript{16} The strategy starts with a special recruitment phase followed by a fitness test, and continues with participation in a recreational sports program.

The recruitment phase consists of three steps: 1) direct mailing; 2) door-to-door visits; 3) program invitation. By means of these steps, sedentary and underactive older adults were screened and invited to participate in a fitness test and subsequently in the GALM recreational sports program.\textsuperscript{15,16,18}

The content of the recreational sports program is primarily based on an evolutionary-biological play theory\textsuperscript{19} and insights from social cognitive theory.\textsuperscript{20} The evolutionary-biological play theory suggests that programs
that are in accordance with the genetic potential are most likely to succeed in developing a lifelong, physically active lifestyle. From social cognitive theory self-efficacy, social support and perceived fitness are manipulated in order to enhance enjoyment in physical activity.\textsuperscript{16,20} To assist the maintenance of physical activity, it was assumed that the GALM sessions should be tailored to the individual’s wishes, preferences and needs.\textsuperscript{21-24} This ultimately led to the versatile content of the GALM recreational sports program, containing physical activities like ball games, swimming, athletics, fitness, etc.

Compared with other more exercise-based physical activity (training) programs, GALM differs on several points: 1) the content of the GALM program is primarily based on behavioral change theories; 2) for reasons of compliance with the program, GALM is versatile and sessions are held once a week; 3) the GALM recreational sports program offers different modes of activities aiming at diverse components of performance-based fitness (strength, aerobic endurance, coordination and flexibility).

\section{Objective of the thesis}

Based on the aforementioned considerations, GALM can be characterized as a multi-modal physical activity program. It differs from other multi-modal exercise programs in that it consists of recreational sports activities. To our knowledge, no study so far has reported on the effects of physical activity, health and fitness after participating in a recreational sports program for older adults.

Based on several mechanisms it is assumed that participation in the GALM recreational sports program will lead to favorable changes in physical activity, health and/or fitness outcomes. First, based on the low initial fitness level of the target group, together with the fact that people with the lowest levels can gain the most,\textsuperscript{11,25} it is expected that GALM may enhance health and/or fitness even though it does not meet all key exercise variables (e.g. type, intensity and volume).\textsuperscript{11,12} Second, thanks to the versatile nature of the GALM recreational sports program participants can develop preferences toward one or more physical activity modes which they may conduct in addition to GALM. If this transfer occurs, the increase in physical activity can lead to improvements in health and/or fitness outcomes.\textsuperscript{26} Third, since the GALM recreational sports program addresses all components of fitness, effects can occur in several performance-based fitness measures.\textsuperscript{11}
Based on these assumptions, the objective of this thesis is to determine the effect of participation in GALM on physical activity, health and fitness outcomes in sedentary and underactive older adults.

1.6 Outline of the thesis
In Chapter 2 the recruitment phase of GALM and its efficiency in selecting and including sedentary and underactive older adults in the 55-65 age category is described.

Chapter 3 depicts the background and intensity of the GALM physical activity program. The theories on which the GALM physical activity program is based and the translation to practice are elaborated on. The intensity of the program is measured objectively, based on heart rate monitoring.

Chapter 4 presents the six-month effects of participation in the GALM program on physical activity, health and fitness outcomes.

Chapter 5 provides the longitudinal results after twelve months of participation in the GALM program for physical activity, health and fitness outcomes.

Chapter 6 describes the longitudinal changes in heart rate during submaximal exercise as an indicator of cardiovascular function after 18 months of participation in the GALM program.

In Chapter 7 the major findings of the study and the overall effects of participation in the GALM program for physical activity, health and fitness outcomes are discussed.
Chapter 1

References


