Promoting physical activity in the rehabilitation setting

voor mam & pap

The study presented in this thesis was performed at the Institute for Research in Extramural Medicine (EMGO Institute), Department of Public and Occupational Health of the VU University Medical Center, Amsterdam, the Netherlands. This was in close collaboration with the Institute for Fundamental and Clinical Human Movement Sciences of the Faculty of Human Movement Sciences from the Vrije Universiteit in Amsterdam, Roessingh Research & Development in Enschede, and the Netherlands Sports Organization for People with a Disability (NebasNsg). The measurements for this study were carried out in the following rehabilitation centres: RC De Hoogstraat, Heliomare, CR Beatrixoord, Het Roessingh CR, SRC Breda, RC Leijpark, RC Tolbrug, Rijnlands RC, SRG Zeeland and Kastanjehof CR. The EMGO Institute participates in the Netherlands School of Primary Care Research (CaRe), which has been re-acknowledged in 2000 by the Royal Netherlands Academy of Sciences (KNAW).

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Table of contents

Chapter 1

General introduction

Physical (in)activity and health

In recent decades the average individual in the industrial world has become less physically active. At work many people sit behind a desk all day, cars are the preferred way of transportation, and the favourite pastime of many people is watching television or surfing the web and playing games on the computer. The implications of such a physically inactive lifestyle for a person's health have been extensively studied. As a result, the negative effects of a physically inactive lifestyle for the general population are well documented.[1-7] An inactive lifestyle is accompanied by higher risks for morbidity and mortality of a great number of chronic diseases, including coronary artery disease, diabetes, colon cancer, and osteoporosis. One study estimated that 35%, 32% and 35% respectively of all coronary artery disease, diabetes and colon cancer deaths in the US could have been prevented if the whole population would have been sufficiently physically active.[4] Consequently, physical inactivity has become a serious burden for public health and an important public health policy issue. In a frequently used consensus statement on a healthy physically active lifestyle, it is recommended that people are moderately physically active at least five days a week for half an hour per day, either continuously or intermittently in intervals of at least 5 minutes.[3] This recommendation aims at improving health rather than physical fitness, since an improvement in physical fitness is not necessarily needed for a positive effect on health. The advantage of focusing on health rather than physical fitness is that the physical activity intensity can be lower, making a physically active lifestyle easier to achieve. Consequently, people do not necessarily have to participate in heavy exercise, but can for example also do their groceries on foot or by bike in order to meet the recommendation for a healthy physically active lifestyle.

Physical activity in people with disabilities

It has been estimated that around 13 to 20% of the western population has one or more disabilities.[8-12] Common causes of disability are musculoskeletal and connective tissue disorders (e.g. arthritis, back disorders), circulatory disorders (e.g. heart disease, stroke), respiratory disorders (e.g. COPD, asthma), nervous and sensory disorders (e.g. multiple sclerosis, spinal cord injury), endocrine, nutritional, metabolic and immunity disorders (e.g. diabetes mellitus, cystic fibrosis, disorders of

the thyroid gland), mental disorders (mental retardation, schizophrenia), visual and hearing impairments.[10] The percentage of people with a disability increases with age and around 40% of the people 65 yr and older has a disability.[9] In the coming decades the ageing of the population will lead to an increase in the absolute number of people with a disability.

The World Health Organization (WHO) defines disability as problems an individual may experience in functioning.[13] Disabilities are the result of health conditions in the context of the person and his/her environment with health conditions being mainly diseases, disorders, injuries and traumas. Such problems with functioning and the risks of secondary health problems can be influenced positively by a physically active lifestyle. For people with a disability a physically active lifestyle could have a positive effect on the risk of coronary artery disease, diabetes mellitus type 2, osteoporosis, osteoarthritis, colon cancer, high blood pressure, decreased balance, decreased strength, decreased endurance, decreased fitness, decreased flexibility, spasticity, weight problems including obesity, depression, urinary infections, diminished self-concept, reduced ability for normal societal interactions and greater dependence upon others.[8,12,14-17] It seems that the beneficial effects of a physically active lifestyle on the health and well-being of people with a disability could be even higher than for the general population.

Furthermore, a physically inactive lifestyle is more common in people with a disability than in the general population.[8,15,18,19] The Healthy People 2010 report on adults aged ≥18 years, reported that in 1997 only 12% of people with a disability participated ≥5 days/week in moderate physical activity for at least 30 minutes per day, compared to 16% of people without disabilities.[18,19] When just looking at leisure time physical activity, the difference between people with and without disabilities was even larger: 56% and 36%, respectively, did not engage in leisure-time physical activity.[18,19]

In conclusion, improving physical activity behaviour in people with disabilities is probably even more important than it already is for the general population. However, far less scientific knowledge is available on physical activity behaviour in people with disabilities than is available for the general population.[8,12,14-17]

Rehabilitation setting

It is believed that rehabilitation is an important phase with respect to a physically active lifestyle for persons with a disability. People who participated in a rehabilitation program, often tend to become physically inactive just after the rehabilitation period. Since rehabilitation treatment usually includes structured sport related physical activities, such as swimming and fitness exercises, people will usually be quite physically active during rehabilitation. However, after the rehabilitation period these structured physical activities end and most rehabilitation centres provide little to no after-care to keep their former patients physically active. After rehabilitation most people have to restart and reorganize their lives and get used to the new situation of having a disability. As a consequence, physical activity usually does not have a high priority after rehabilitation and people probably easily become sedentary.

During rehabilitation and especially the period near the end of rehabilitation seems to provide an excellent opportunity to start promoting a physically active lifestyle. Since people are learning to live with a disability, it seems a good strategy to immediately integrate physical activity into the new everyday routine. A helpful way to accomplish this is probably to maintain the physical activity level that was reached during the rehabilitation period by integrating rehabilitation initiated activities into everyday life. Thus, it seems important to make the conversion from planned and structured rehabilitation activities to self-initiated daily physical activities.

Promoting physical activity after rehabilitation

The previous paragraphs showed that a physically active lifestyle is important for people with a disability, and that rehabilitation offers a good opportunity to promote such a lifestyle. This is why the sport stimulation program ‘Rehabilitation & Sports’ (R&S) was started in 1997. The goal of the R&S program was to improve sport participation after rehabilitation. The main part of the R&S program consisted of a tailored sport advice, including available and appropriate sports locations near people’s homes. The sport stimulation program originally started in nine Dutch rehabilitation centres in cooperation with the Netherlands Sports Organization for People with a Disability (NebasNsg). In order to evaluate the effectiveness of this program a large multi-centre trial was started in 2000 that included four of the nine original R&S centres, which served as the intervention centres (figure 1). A control

group was selected from six rehabilitation centres, which did not participate in the R&S program and only provided usual care. At the start of the trial the daily physical activity promotion intervention 'Active after Rehabilitation' (AaR) was designed, which was additional to the R&S program. The AaR intervention aimed at improving daily physical activity in general after rehabilitation, using personalized tailored counselling, based on the stages of behavioural change concept of the Transtheoretical model.[20] This concept describes the stages a person goes through when changing his health behaviour and has also been applied to physical activity behaviour.[21,22] Subjects in different stages are approached in a different stage-specific way. Participants in the intervention centres were randomly allocated to a group receiving just R&S and a group receiving the combination of R&S and AaR (figure 1).

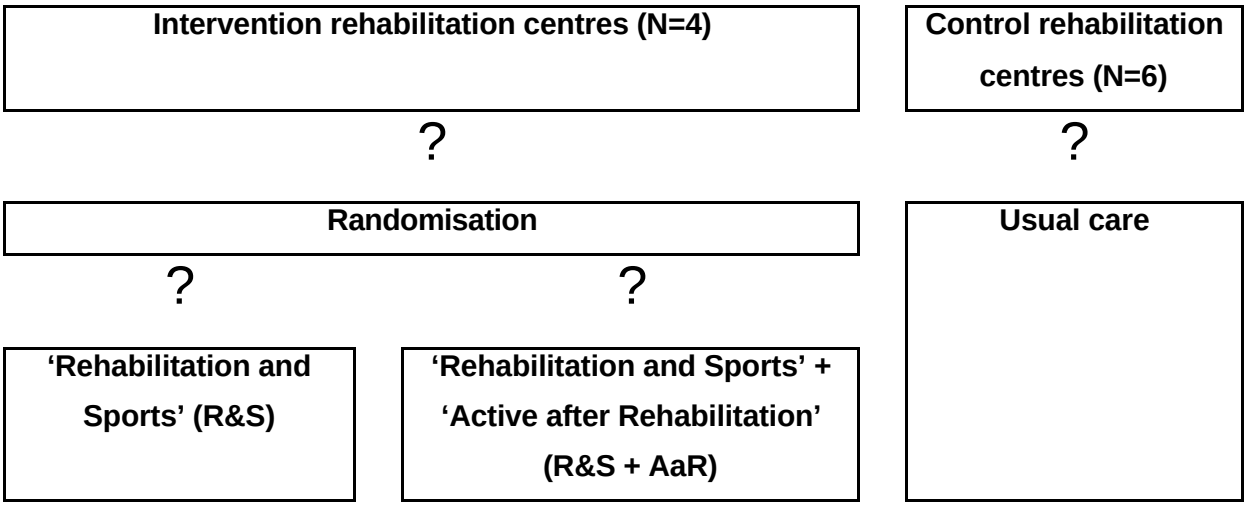

Figure 1: Study design of the multi-centre trial

This multi-centre trial was a cooperation between researchers from the Department of Public and Occupational Health of the VU University Medical Centre in Amsterdam, Roessingh Research and Development in Enschede and the Faculty of Human Movement Sciences of the Vrije Universiteit in Amsterdam. The trial was supported by the Netherlands Organization for Health Research and Development (ZonMw; project number: 2001.0008), and the NebasNsg. The trial was carried out in the following ten rehabilitation centres: RC De Hoogstraat, Heliomare, CR Beatrixoord, Het Roessingh CR, SRC Breda, RC Leijpark, RC Tolbrug, Rijnlands RC, SRG Zeeland and Kastanjehof CR; with the first four being the intervention centres. This thesis will present part of the results from this multi-centre trial.

Purpose and outline of the thesis

The main purpose of this thesis is to determine the effectiveness of the R&S intervention alone and the effectiveness of the combination of the R&S and AaR interventions, with respect to sport participation and physical activity behaviour for people with a physical disability, after their rehabilitation. The secondary purpose is to take a closer look at the underlying working mechanisms of these interventions with a specific focus on determinants of physical activity.

The theoretical basis of this thesis will be laid out in chapter 2. Since no suitable model for this thesis existed, a systematic literature search was performed to develop and propose a conceptual model of physical activity behaviour in people with a disability, based on existing models. The conceptual model describes the relationship between physical activity behaviour, its determinants and functioning in people with a disability.

In order to determine daily physical activity in a large group of people with disabilities a physical activity questionnaire for this specific population was needed. Since no well established physical activity questionnaires existed for people with disabilities, the recently developed 'Physical Activity Scale for Individuals with Physical Disabilities' (PASIPD)[23] was used in the multi-centre trial. Not much was known about the psychometric qualities of the PASIPD. Hence, a study was carried out to determine its test-retest reliability, as well as its criterion validity. The results of this study are presented in chapter 3.

To understand and change physical activity behaviour, knowledge is needed about the factors that determine it. However, there is a lack of knowledge about determinants of physical activity behaviour in people with disabilities. Chapter 4 provides some insight into which variables are correlated with physical activity behaviour during outpatient rehabilitation.

The main question of this thesis is answered in chapters 5 and 6. Chapter 5 presents the effects of the R&S program and the effects of the R&S program combined with the AaR program, on sports participation and daily physical activity behaviour in people with disabilities, nine weeks after the conclusion of their in- or outpatient rehabilitation period. The effectiveness of the interventions one year after rehabilitation is presented in chapter 6.

Chapter 7 focuses on the underlying working mechanisms of the interventions. The role of several determinants of physical activity in the interventions' working mechanisms at both the short and longer-term follow up measurements was assessed.

Chapter 8 contains the general discussion, in which the overall conclusions of this thesis are summarized. Furthermore, methodological issues related to performing this multi-centre study are discussed. Finally, recommendations for practice, policy as well as for future research are formulated.

Chapter 2 through 7 are separate articles that have been published, accepted or submitted for publication in international, peer-reviewed journals. As a consequence, there is some overlap between these chapters.

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Chapter 2

Physical activity for people with a disability: a conceptual model

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Abstract

The promotion of a physically active lifestyle has become an important issue in health policy in first world countries. A physically active lifestyle is accompanied by several fitness and health benefits. Individuals with a disability can particularly benefit from an active lifestyle. Not only will this reduce the risk for secondary health problems, but all levels of functioning can be influenced positively. The objective of this paper is to propose a conceptual model that describes the relationships between physical activity behaviour, its determinants and functioning of people with a disability. Literature was systematically searched for articles considering physical activity and disability. Furthermore, models relating both topics were looked for in particular. No models were found relating physical activity behaviour, its determinants and functioning, in people with a disability. Consequently, a new model the 'Physical Activity for people with a Disability model' (PAD model) was constructed based on existing models of disability and models of determinants of physical activity behaviour. Starting point was the new WHO 'Model of Functioning and Disability' (ICF), which describes the multidimensional aspects of functioning and disability. Physical activity behaviour and its determinants were integrated into the ICF model. The factors determining physical activity were based mainly on those used in the 'Attitude, Social influence and self-Efficacy model' (ASE model). The proposed model can be used as a theoretical framework for future interventions and research on physical activity promotion in the population of people with a disability. The model currently forms the theoretical basis for a large physical activity promotion trial in ten Dutch rehabilitation centres.

1. Physical Inactivity in People with a Disability

For the general population the benefits of a physically active lifestyle are well known.[1-5] Such a lifestyle is accompanied by lower risks for morbidity and mortality of a great number of chronic diseases, such as coronary artery disease, diabetes and colon cancer.[6] In the industrial world physical inactivity has become more and more common and the resulting health problems have become a serious burden for public health. These facts have made the promotion of physical activity behaviour in the general population an important public health policy issue.[1,2,5] Consequently, several programs for the stimulation of a physically active lifestyle were designed and implemented into practice.[7-11]

Until recently not much attention has been paid to the physical activity behaviour of people with a disability in relation to their health and well-being. However, recent articles have emphasised the importance of a physically active lifestyle for people with a disability.[12-17] It is believed that people with a disability can also benefit from a physically active lifestyle. People's health condition and secondary health problems can lead to problems with everyday functioning (disability). Such problems with functioning, and especially problems with mobility, can be influenced positively by a physically active lifestyle and thus reduce disability. Moreover, secondary health and functioning problems in people with a disability that could be prevented or reduced by a physically active lifestyle include the risk of coronary artery disease, diabetes mellitus type 2, osteoporosis, osteoarthritis, colon cancer, high blood pressure, decreased balance, decreased strength, decreased endurance, decreased fitness, decreased flexibility, spasticity, weight problems including obesity, depression, urinary infections, diminished self-concept, reduced ability for normal societal interactions and greater dependence upon others.[12-18] This shows that a physically active lifestyle for the health and well-being of people with a disability is probably even more important than for the general population. However, the mentioned articles also showed there is still a lack in scientific evidence and knowledge on this subject in this specific population.[12-17]

There is a substantial group of people with a disability. It is estimated that around 13 to 20 percent of the western population has one or more disabilities.[14,15,19-21] This percentage varies with the used definition of disability which is usually close to the legal definition in the United States as formulated in the Americans with Disabilities

Act of 1990. This definition states: 'The term "disability" means, with respect to an individual – (A) a physical or mental impairment that substantially limits one or more of the major life activities of such individual; (B) a record of such an impairment; or (C) being regarded as having such an impairment.[22] Later on in the proposed model we use the WHO definition of disability as formulated in table 1. The percentage of people with a disability increases with age and around 40% of the people 65 yr and older have a disability.[20] The most common causes of disability are musculoskeletal and connective tissue disorders (e.g. arthritis, back disorders), circulatory disorders (e.g. heart disease, stroke), respiratory disorders (e.g. COPD, asthma), nervous and sensory disorders (e.g. multiple sclerosis, spinal cord injury), endocrine, nutritional, metabolic and immunity disorders (e.g. diabetes mellitus, cystic fibrosis, disorders of the thyroid gland), mental disorders (mental retardation, schizophrenia), visual and hearing impairments.[21]

Table 1: The definitions of the levels of functioning based on the 'International Classification of Functioning, Disability and Health' (ICF).[26] The italic printed terms are the negative counterparts of the normal printed term(s) above them.

Term	**ICF definition**
Body functions	The physiological functions of body systems (including psychological functions).
Body structures	Anatomical parts of the body, such as organs, limbs and their components.
Impairments	Problems in body function or structure as a significant deviation or loss.
Activities	The execution of a task or action by an individual.
Activity limitations	Difficulties an individual may have in executing activities.
Participation	Involvement in a life situation.
Participation restrictions	Problems an individual may experience in involvement in life situations.
Functioning	The umbrella term used for all three levels, namely body functions and structures, activity and participation.
Disability	The umbrella term for the problems an individual may experience in functioning, namely impairments, activity limitations and participation restrictions.

People with a disability are on average even more inactive than the general population.[13,14,23] The Healthy People 2010 report on adults aged ≥18 years, reported that in 1997 only 12% of people with a disability participated ≥5 days/week in moderate physical activity for at least 30 minutes per day, compared with 16% of people without disabilities.[23] When just looking at leisure time physical activity, the difference between people with and without disabilities is even larger: 56% and 36% respectively, did not engage in leisure-time physical activity.[23] For people with a disability who participated in a rehabilitation program, such a sedentary lifestyle probably already originates just after the rehabilitation period. Although most patients participate in numerous sports and other physical activities during their rehabilitation program, this relatively high physical activity status is easily lost at the end of the rehabilitation period. Most people need a lot of time and energy to restart and reorganise their lives after rehabilitation and to get used to the new situation with having a disability. On top of this, most rehabilitation centres provide little to none after-care to keep their former patients physically active after the rehabilitation period. Consequently, the sudden lack of planned and structured activities after rehabilitation is not replaced by self-initiated activities.

Concluding, promotion of a physically active lifestyle for people with a disability is needed. Although adjacent fields provide some theoretical framework, a model for this promotion could not be found. Therefore, the objective of this article is to propose a theoretical model that describes the relationships between physical activity behaviour, its determinants and functioning in people with a disability.

2. Literature Search

2.1. Methods of the Literature Search

Medline, Psycinfo and Sportdiscus were systematically searched for relevant articles in May 2002. We specifically looked for studies describing the relationship between physical activity and disability. Additionally, we looked for models on disability and models on physical activity and its determinants.

Keywords used in Medline were: sports, exercise, physical activity, walking/physiology, chronic disease, chronic disease/prevention and control, chronic disease/rehabilitation, rehabilitation, lifestyle, health promotion, health status, theoretical models, behavioural models and psychological models. Psycinfo was

searched using physical activity, exercise, disability, chronic disease, rehabilitation, health promotion and psychological models as search terms. Sportdiscus was searched using the following index words: exercise/physical activity, rehabilitation, chronic disease, health promotion and theoretical model.

Furthermore, authors of selected articles were checked in Medline, Psycinfo and Sportdiscus for other relevant articles. Cited reference searches were performed for key articles. Finally, the references of relevant articles were checked for additional relevant articles.

2.2. Results of the Literature Search

The searches of the Medline, Psycinfo and Sportdiscus databases resulted in 965 hits. Based on title and abstract 22 articles were selected. Of these 22 articles, four were directly relevant for the purpose of this review. The remaining 18 articles were only used to identify other articles directly relevant for this review. The search for other articles by the authors of these 22 selected articles and a cited reference search resulted in 13 additional relevant articles. After checking the references of these 35 found articles another 29 relevant articles were identified. Concluding, in total we identified 46 articles relevant for the construction of our model, including 18 reviews.

No model that integrated physical activity and its determinants with functioning and disability was found. Therefore, we decided to combine a model on functioning and disability with existing models of physical activity behaviour.

3. Models of Disability

Over the years numerous models of disability have been presented in the literature.[24-37] There are two major disability models, on which many of the other models are based: Nagi's model[24] and the WHO model associated with the International Classification of Impairment, Disability and Handicap (ICIDH).[25] These two medically orientated models are quite similar and differ mainly in terminology. The disablement process is linear in both models, moving from pathology to impairment to disability (called functional limitations in Nagi's model) and to handicap (called disability in Nagi's model). The ICIDH definition of disability is: In the context of health experience, any restriction or lack (resulting from an impairment) of ability to

perform an activity in the manner or within the range considered normal for a human being.[25] Nagi defines disability as a: Pattern of behaviour that evolves in situations of long-term or continued impairments that are associated with functional limitations.[24] However, two major problems of both original models are the insufficient attention paid to the environment and the lack of clarity in the nature of the relationship between the different components (all relations seem unidirectional and causal).[38-40] As a result of these shortcomings and issues regarding the classification itself, the WHO decided to revise the ICIDH. This resulted in the 'International Classification of Functioning, Disability and Health' (ICF).[26] This new classification also contains a new and more dynamic model of disability: the 'Model of Functioning and Disability'.

3.1. The Model of Functioning and Disability

The ICF model (figure 1) describes an individual's functioning in a specific domain as a dynamic interaction or complex relationship with environmental and personal factors, given certain health conditions. The ICF definitions of the different levels of functioning and their negative counterparts are given in Table I.[26] The umbrella term for problems an individual may experience with functioning (impairments, activity limitations and participation restrictions) is 'disability'. Disabilities are the result of health conditions in the context of the person and environment. Health conditions are

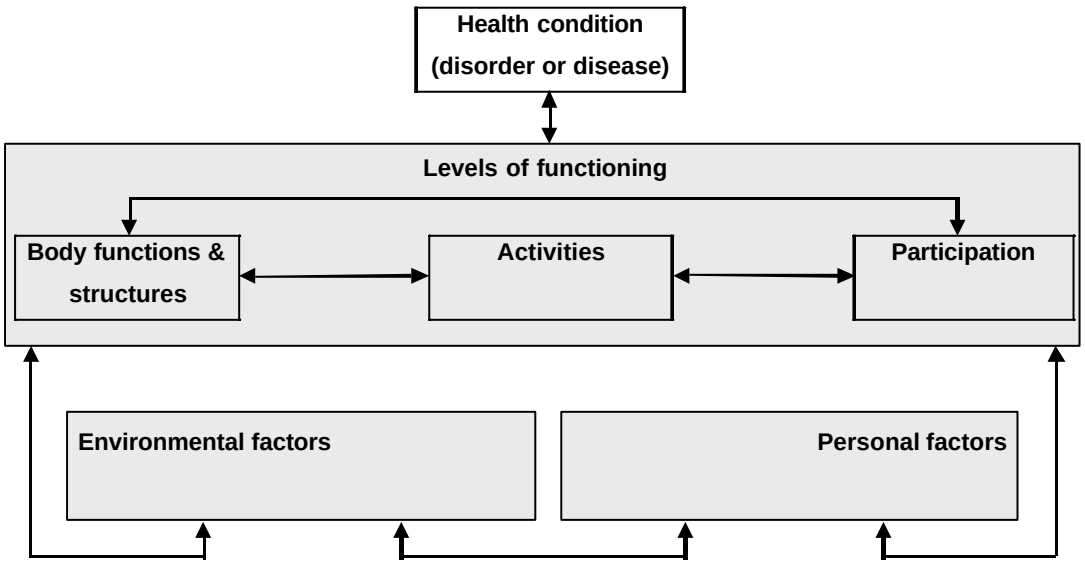

Figure 1: The model of functioning and disability (ICF model).[adapted from 26, with permission of the World Health Organization]

mainly diseases, disorders, injuries and traumas. Health conditions are classified primarily in the WHO International Classification of Diseases (Tenth Revision, ICD-10),[41] while functioning and disability associated with these health conditions are classified in the ICF. Consequently, ICD-10 and ICF are complementary to each other.[26]

"Environmental factors make up the physical, social and attitudinal environment in which people live and conduct their lives."[26] These factors are external to individuals and can be in the immediate physical and social environment of the individual, including settings such as home, workplace and school. But these factors can also be further away in society and include formal and informal social structures, services and overarching approaches or systems in the community or society that have an impact on individuals. Examples are infrastructure, laws and regulations, climate, attitudes and ideologies.[26]

Personal factors are the particular background of an individual's life and living, and comprise features of the individual. These factors include gender, race, age, health conditions, fitness, lifestyle, coping styles, social background, education, profession, past and current experience, overall behaviour pattern and other characteristics. All or any may play a role in disability at any level.[26]

This multidimensional ICF model could be applied to all individuals, with or without disability. The ICF model takes a broad perspective, so that the 'template' can integrate various personal and environmental factors that encompass all areas of participation. In any form of human behaviour, both personal and environmental factors play a role in the individual's capacity to perform and sustain the behaviour. We took the ICF model as the framework for our new conceptual model, focussing on people with a disability and physical activity as part of people's functioning.

4. Models on Determinants of Physical Activity Behaviour

Research in healthy subjects has shown there are numerous determinants of physical activity. Dozens of demographic, biological, cognitive, behavioural, social, cultural and environmental factors have been studied over the years for their relationship with physical activity behaviour.[42-48] These determinants can be divided into immutable (age, gender, race, etc.) and modifiable determinants (psychosocial behavioural factors, systems of support, etc.).[49] The modifiable determinants are the

most interesting in the context of physical activity promotion since these can be targeted in interventions.

Over the years various models have been used that describe the way in which physical activity behaviour is determined.[44,45,49] The most frequently used theories concerning physical activity behaviour are the Social Learning/Cognitive theories,[50] the Health Belief model,[51] the Theory of Planned Behaviour,[52] and the Transtheoretical model.[53] De Vries et al. combined elements of the Social Learning theory and the Theory of Planned Behaviour into the 'Attitude, Social influence and self-Efficacy' model (ASE model).[54,55]

4.1. The Attitude, Social Influence and Self-efficacy Model

The ASE model (figure 2) includes the three most important psychosocial determinants of physical activity behaviour: attitude, social influence and self-efficacy.[42-45] Attitude towards physical activity is what an individual thinks and expresses about a physically active lifestyle for him or herself. Social influence is what other people think about a physically active lifestyle for this individual. Self-efficacy is this individual's confidence of being able to successfully engage in a certain physical activity behaviour, given a range of different contexts, including different barriers.[56] These three determinants are influenced by external variables that are similar to the 'personal factors' in the ICF model (for example gender, race,

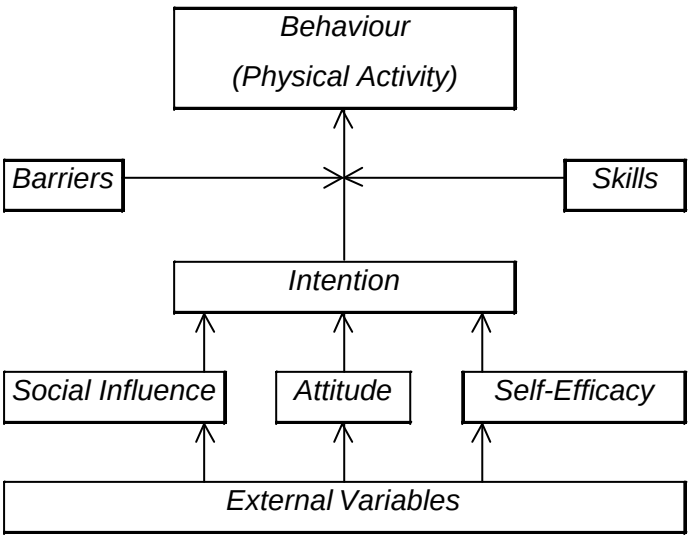

Figure 2: The attitude, social influence and self-efficacy model (ASE model).[adapted from 54, with permission of Oxford University Press]

age and social economic status). External variables only influence physical activity through one or more of the three main determinants. Attitude, social influence and self-efficacy determine physical activity behaviour through the general concept intention towards physical activity. However, the behaviour is not only determined through intention, but depends also on a person's skills and on barriers that could prevent the actual behaviour. The ASE model forms the basis of the determinants of physical activity in our integrated model.

4.2. Stages of Change

The Transtheoretical model contains the stages of change concept, which describe the stages a person goes through when changing his health behaviour. Interventions focussing on the promotion of health behaviour should approach people in each stage of change in a different stage-specific way.[53] Table 2 shows the stages of change for physical activity behaviour.[57] For the definition of the different stages, 'regular physically active' is defined as at least 5 days a week half an hour of moderate intensity physical activity.[1]

De Vries et al. later integrated the stages of change in de ASE model. They placed 'precontemplator' and 'contemplator' in the intention box, 'action' in the behaviour box and after the behaviour box two extra boxes were placed containing maintenance and relapse.[55] It seems the stages of change can actually be seen as a combination of physical activity status and intention towards physical activity behaviour.

Table 2: The different stages of change for physical activity behaviour.[57]

Stage of change	**Definition**
Precontemplation	Inactive and no intention to become more active in the next 6 months.
Contemplation	Inactive, but intention to become more active in the next 6 months.
Ready for action/ Preparation	Active, but not regular.
Action	Regular active, but only started in the last 6 months.
Maintenance	Regular active for at least 6 months.
Relapse	Falling back to an earlier stage of change.

5. The Integrated Model of Physical Activity and Disability

After making some adjustments to the ASE model, we integrated this model with the ICF model into the Physical Activity for people with a Disability model (PAD model, figure 3). We used the ICF model as the framework for the PAD model. This framework is shown by the large bold printed concepts and the thick arrows in figure 3, while the determinants of physical activity behaviour are shown in the small boxes. The thin arrows in the PAD model represent the pathway through which these factors determine physical activity, although not all possible pathways and relations are shown in the model. Most of the thin arrows also work in the opposite direction and, as shown in the general framework, all components of the integrated model more or less interact with each other. Although important examples are given for each determinant of physical activity, there are more determinants of physical activity than are shown.[42-48] If determinants that are not represented directly in the PAD model are important factors for physical activity behaviour (e.g. for a certain subgroup), they can act through the facilitator and barrier boxes. Thus, the PAD model does not rule out other possible determinants, but for the sake of clarity the model focuses on the most important factors and on the relevant relations for determining physical activity behaviour.

5.1. Physical activity and the levels of functioning

Physical activity is part of the levels of functioning. It can be considered at all three levels of functioning. For example having legs and being able to move them is functioning at the level of body functions and structures. Walking is part of the activities level. While walking to the supermarket and buying groceries is at the level of participation, taking into account the social component. Of course, all three levels are closely interrelated and the border between them is sometimes vague. Consequently, the benefits of a more physically active lifestyle can be described at three levels as well. At the body functions and structures level increased physical activity can, for example, lead to improvements in muscle power and cardiopulmonary function. At the activities level it can lead to better and easier performance of actions, for example the ability to walk. While a physically active lifestyle also improves functioning at the level of participation, meaning better performance in real life situations, and thus in society.

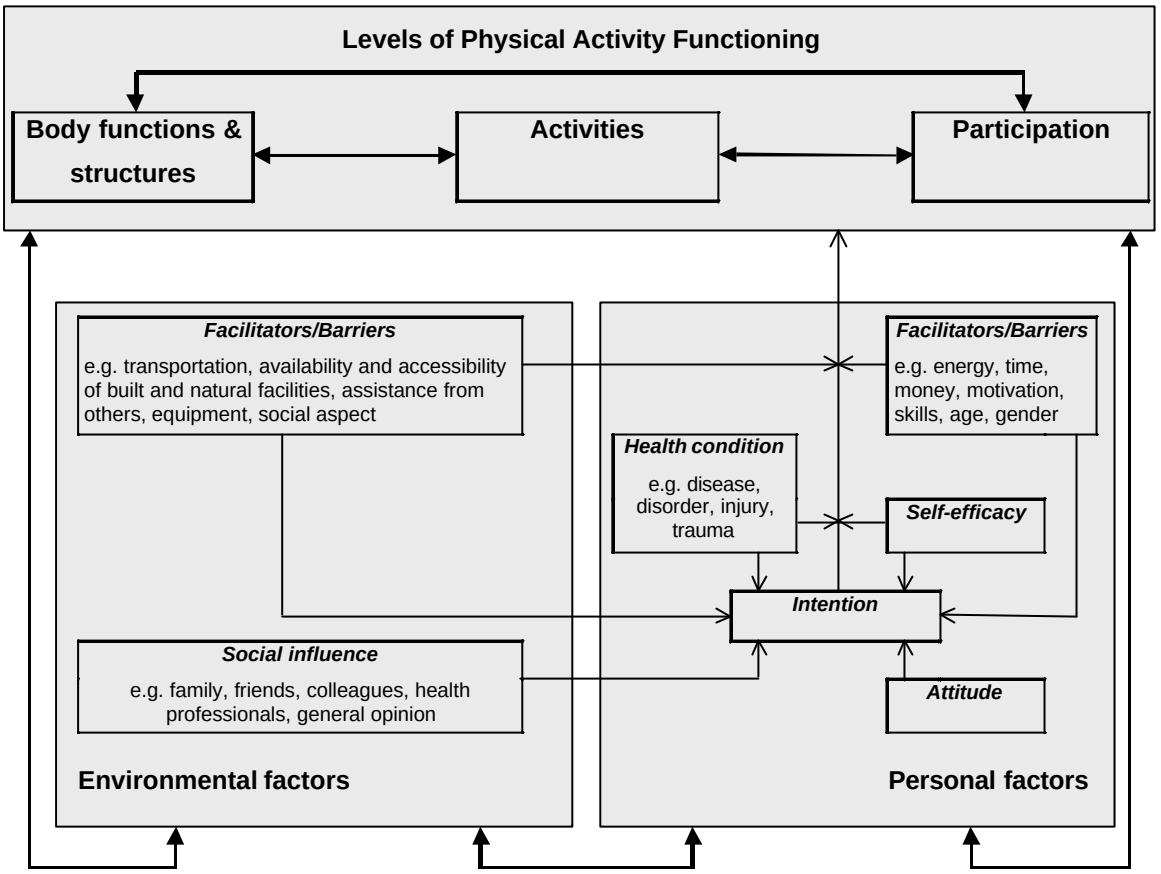

Figure 3: The physical activity for people with a disability model (PAD model), an integrated model of physical activity behaviour and its relation with functioning and disability.

5.2. Environmental factors

The main environmental determinants of physical activity are believed to be social influence and environmental facilitators and barriers.[43,45-48] Social influence includes the opinion of family, friends, colleagues and health professionals, but also the general opinion in society. Especially social influence of family and friends was repeatedly shown to have a positive influence on physical activity behaviour in healthy subjects.[45-48] In people with a disability the influence of health professionals is likely to be more important than in the general population. Numerous environmental barriers have been identified for healthy subjects.[43,45-48] Examples of environmental barriers for people with a disability could be poor transportation, poor availability and accessibility of equipment and built and natural facilities to become more physically active, lack of assistance to be physically active, not wanting to be physically active alone, uncomfortable with physical activity in the company of persons without a

disability, climate and season. Rimmer et al. found that transportation was a barrier for physical activity behaviour in African American women with physical disabilities.[58] The opposite of these barriers are usually seen as facilitators, such as having a good accessible park nearby to go for a walk, having good transportation possibilities to a swimming group for people with rheumatoid arthritis, having access to a handbike to go for a ride or having nice social contacts while being physically active

5.3. Personal factors

Research in healthy subjects has shown that many personal factors influence physical activity behaviour.[44-47,49] These include demographic, biological, cognitive and behavioural factors.[45,47] Only the factors that are considered the most important in determining physical activity in people with a disability are shown in the PAD model. For people with a disability their health condition(s) is a very important determinant of physical activity behaviour. An Australian study in an urban-representative population showed that twenty percent of the survey population reported a current injury or disability as preventing them from being more physically active.[59] In fact, it often happens that due to health condition, a person's primary disability is having problems with physical activity. The severity of the health condition is of importance for the degree of disability and for the impact on physical activity behaviour. However, the degree of disability and physical activity behaviour is also determined by other factors. Thus, people with a similar health condition do not necessarily have the same degree of functioning and disability or the same physical activity behaviour.

Other important personal determinants of physical activity behaviour are the intention towards physical activity, the attitude towards physical activity, self-efficacy and personal facilitators and barriers. Kinne et al. found significant correlations for exercise maintenance with motivational barriers and self-efficacy, but no significant correlations with environmental barriers and disability in 113 adults with mobility impairments.[60] However, the subgroups of the different health conditions were small, which could be the reason that no statistically significant relation was found between disability and physical activity. Examples of important personal barriers are lack of energy, money, motivation, skills and time, and off course age and gender are also important.[44-47,49] The opposites of these barriers are facilitators, for example having

enough energy, money, motivation, skills and time. Rimmer et al. found that lack of energy and the cost of exercise programs were personal barriers to physical activity participation in 50 African American women with disabilities. However, no significant effects were found on other expected barriers such as lack of time, boredom and laziness.[58]

Intention is the central determinant of physical activity. The intention to participate in a physical activity can exist long before the actual activity, but can also emerge at the last moment when an opportunity to be active arises. Without the intention to participate in a certain structural behaviour, the actual behaviour will not take place. All other determinants influence a person's intention to remain or become physically active or inactive.[52,54] However, the intention to be active does not necessarily lead to the actual performance of the physical activity behaviour. Environmental and personal facilitators and barriers, self-efficacy and a person's health condition determine whether the intention will lead to the desired physical activity behaviour.

5.4. Stages of change

Although not directly visible in the PAD model the stages of change of the Transtheoretical model is compatible with in the PAD model. It is linked to the PAD model in a similar way as it is to the ASE model.[55] Stages of change can be helpful when applying the PAD model to interventions on the promotion of physical activity behaviour in people with a disability. Intention and actual physical activity status can be combined into 'stage of change',[53] as was done in the ASE model.[55] Given a certain definition of physical activity, individuals can be divided into either being physically active or physically inactive. As for intention, people can be divided into those who intend to change their behaviour and those who intend to maintain their current behaviour. Combining these two divisions leads to four groups of individuals. These groups in terms of stages of change are: precontemplators, contemplators, those in action/maintenance and those intending to terminate (relapse).[53] These four stages can be extended easily to five or six stages, also distinguishing between action and maintenance, and adding the ready for action stage.[53]

6. Recommendations for Future Research

The PAD model aims to show which variables determine physical activity behaviour of people with a disability. Future research has to demonstrate how realistic and practically relevant this suggested integrated conceptual model is. Special attention should be paid to whether the model does indeed contain the correct combination of factors determining physical activity behaviour in people with a disability. The determinants of physical activity as proposed in the model are primarily based on research in healthy populations. It could be that not all determinants are as important as expected, or that important determinants are missing in the context of persons with a disability. It is also likely that the determinants have a different impact on groups with different health conditions and disabilities. Special attention should also be paid to identifying the important personal and environmental facilitators and barriers of physical activity behaviour in people with a disability. The PAD model could be used as a theoretical framework for future interventions and research on physical activity promotion in the population of people with a disability. The model could help future studies to identify which combinations of personal and environmental factors are important in the physical activity behaviour of different subgroups of people with a disability. Consequently, this would enhance the possibilities to design tailored physical activity promotion interventions, in which the most important personal and environmental barriers should be minimised and the contribution of possible facilitators should be increased. Modifiable determinants are of course more interesting for interventions than immutable determinants. However, interventions should focus on the whole spectrum of determinants and their underlying relationships within the context of the person and environment to achieve an optimal result.

The PAD model already forms the theoretical basis of a large intervention study aimed at improving physical activity behaviour of people with a disability. In 1997, half of the Dutch rehabilitation centres started a sport promotion program to keep patients physically active after the end of their rehabilitation period. The effects of this program and of a similar new intervention program aimed at the promotion of general physical activity behaviour after rehabilitation are currently being evaluated in a multi-centre controlled trial.[61] Although, the PAD model specifically focuses on physical activity for people with a disability, the general idea of the model can be applied

much broader. For example it can be applied to other healthy lifestyle behaviours, such as smoking cessation and healthy nutrition. As mentioned earlier, this broad perspective originates in the ICF model. Thus, adapted versions of the PAD model could possibly be used in other lifestyle studies as well.

In the discussion on promotion of physical activity behaviour, the next question refers to the desired amount of physical activity for people with a disability in terms of duration, frequency and intensity in order to improve functioning. This question is not easy to answer. The currently most frequently used recommendation for a healthy physically active lifestyle in the general population is at least 5 days a week half an hour of moderate intensity physical activity.[1] This recommendation does not aim at improving physical fitness, but at improving health. An improvement in physical fitness is not necessarily needed for a positive effect on health. The advantage of focussing on health rather than fitness is that the physical activity intensity can be lower, making a physically active lifestyle easier to achieve. Focussing on improvements in functioning and health, rather than physical fitness, is also favourable for people with a disability.[18] However, there is to little data to support whether the above recommendation is also applicable to people with a disability. The population of people with a disability is different from the general population in the amount of physical activity they can achieve and endure. For people with impaired mobility a smaller amount of physical activity is probably already beneficial for their health. However, there is no evidence as to which amounts of physical activity are beneficial for people with a disability. This absence of data could cause a problem when applying the stages of change model to people with a disability. If the recommendation does not translate to the population of people with a disability, differentiating between those who are sufficiently physically active and those who are inactive becomes difficult.

Another important issue concerning the amount of physical activity is that not for all types of disability more physical activity is always better. People can have contraindications for physical activity or for certain elements of physical activity. For every person with a disability there is probably a certain amount of physical activity beyond which a further increase is no longer beneficial or even harmful. For some disability types this amount will be quite low. Physical activity promotion for people with a disability should focus on finding the appropriate activity for the individual and on finding an optimum in the amount of physical activity rather than just focus on the

promotion of more physical activity.[13,14,18] Concluding, more research is needed concerning the amount and form of physical activity that is beneficial for the health of people with a disability. It should be taken into account that the optimal amount and form of physical activity most likely differs between disability types and probably even between individuals with the same disability type.

7. Conclusion

The conceptual integrated model presented in this review describes the possible relationship between physical activity behaviour, its determinants and functioning in people with a disability. The PAD model was proposed to better understand physical activity behaviour and how it can be improved among people with a disability, which ultimately might improve their functioning and reduce their disability.

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Chapter 3

The Physical Activity Scale for Individuals with Physical Disabilities: test-retest reliability and comparison with two accelerometers

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Submitted for publication

Abstract

Objectives. To determine the test-retest reliability and the criterion validity of the Physical Activity Scale for Individuals with Physical Disabilities (PASIPD).

Methods. Forty five non-wheelchair dependent subjects were recruited from three Dutch rehabilitation centers. Subjects had one of the following diagnoses: stroke, neurological disorders, orthopedic disorders, spinal cord injury, back disorders, chronic pain or whiplash. To determine the test-retest reliability of this 7-day recall physical activity questionnaire, subjects filled in the PASIPD twice, one week apart. During this week subjects wore a MTI/CSA and a RT3 accelerometer in order to determine criterion validity.

Results. The test-retest reliability Spearman correlation coefficient of the PASIPD was 0.77. The criterion validity Spearman correlation coefficients were 0.30 and 0.23 respectively, when compared to the MTI/CSA and the RT3 accelerometer.

Conclusions. Both the test-retest reliability and criterion validity of the PASIPD are comparable to well established self-report physical activity questionnaires for the general population.

Introduction

The importance of a sufficiently physically active lifestyle for a person's health is well established.[1-5] For people with a physical disability a physically active lifestyle could improve every day functioning, reduce disability and reduce the risk of secondary health problems.[6-9] However, people with a physical disability are even more sedentary than the general population.[10]

In monitoring and intervention studies focusing on physical activity behaviour in people with disabilities, there is a need for a valid and reliable measurement instrument of physical activity for this specific population. Physical activity recall questionnaires are the most common and practical measures of physical activity in large population studies, because they are valid, reliable, easy, low-cost methods, that do not alter the subjects' behaviour.[11-13] For the healthy population numerous physical activity questionnaires exist.[11-13] However, for people with a physical disability a questionnaire is needed that includes more population specific physical activity patterns. Consequently, the Physical Activity Scale for Individuals with Physical Disabilities (PASIPD) was designed.[14]

Washburn et al. reported data on the internal consistency and construct validity of this questionnaire.[14] However, since no data have been reported on the test-retest reliability and criterion validity of the PASIPD, the current study was performed. The objective of this study was to determine the test-retest reliability of the PASIPD and to determine the criterion validity of the PASIPD by comparing it with the MTI/CSA accelerometer and the RT3 accelerometer.

Methods

Participants

Fortyfive subjects were recruited from the adult in- and outpatient population of three Dutch rehabilitation centres and from people who had been patients in the previous two years. Participants had to have one of the following diagnoses: stroke, neurological disorders, orthopedic disorders, spinal cord injury, back disorders or whiplash. Patients were included if the following criteria were met: (A) sufficient cognitive abilities to participate; (B) no medical contra indications for participation; (C) no terminal or very progressive disease; (D) sufficient understanding of the Dutch language; (E) non-wheelchair dependent. Potential participants were identified by

health care professionals in the rehabilitation centres and included into the study by the research assistant of the centre, who gave oral information and asked for written informed consent. The study was approved by the Medical Ethics Committee of Rehabilitation Centre Het Roessingh in Enschede, the Netherlands.

Outcomes

The PASIPD is a 7-day recall physical activity questionnaire developed especially for people with physical disabilities.[14] It consists of questions on leisure time, household and work-related physical activities. The PASIPD was translated into Dutch, and question 10 (lawn work or yard care) and 11 (outdoor gardening) of the original questionnaire were integrated into a single question, since this better represented the Dutch situation. This made the Dutch PASIPD a 12-item questionnaire, from which a total physical activity score was calculated following Washburn et al.[14]

The MTI/CSA accelerometer model 7164 (Manufacturing Technologies, Inc. (MTI), Fort Walton Beach, FL; formerly manufactured by Computer Science and Applications (CSA)) is a small (51 x 41 x 15 mm), lightweight (43 gram) uniaxial accelerometer and was worn on the right hip. The MTI/CSA detects vertical accelerations ranging from 0.05 to 2 G, with a frequency response of 0.25 – 2.5 Hz to limit the measurement of non-human movements. The MTI/CSA converts the vertical accelerations into activity counts per minute. For the comparison with the PASIPD the total number of activity counts was calculated over the same 7-day period as for which the PASIPD was completed. Data from the MTI/CSA were transferred to a personal computer using software from the manufacturer.

The RT3 Triaxial Research Tracker (Stayhealthy Inc., Monrovia, CA; replacement of the Tritrac R3D) is a small (71 x 56 x 28 mm) and lightweight (65 gram) triaxial accelerometer and was worn on the right hip. It measured vertical, anteroposterior and mediolateral accelerations, which it converted to activity counts per minute for all three axes. From the counts of all three axes, the vector magnitude activity counts were calculated. For the comparison with the PASIPD the total number of vector magnitude activity counts was calculated over the same 7-day period as for which the PASIPD was completed. Data from the RT3 were transferred to a personal computer using software from the manufacturer.

Data Collection

Subjects filled in the PASIPD for the first time at the rehabilitation centre or at home, under supervision of a research assistent. Subjects then received instructions about the MTI/CSA and RT3, after which both accelerometers were attached to the right hip with a fully adjustable belt. Subjects were instructed to take off the accelerometers only during sleep and water activities. Neither of the accelerometers gave the subjects feedback on their physical activity behaviour. Subjects wore both accelerometers simultaneously for 7 full days until the second appointment with the research assistant, during which the PASIPD was filled in for the second time.

Table 1: Personal characteristics for the participants (n=45).

Characteristic	**Value**
Gender man, *n (%)*	18 (40)
Mean age ± SD, *y*	47 ± 12
Mean body weight ± SD, *kg*	75 ± 14
Mean body height ± SD, *m*	1.74 ± 0.10
Mean body mass index ± SD, $kg \cdot m^{-2}$	25.0 ± 3.9
Diagnosis group, *n (%)*	
Stroke	13 (29)
Neurological disorders	4 (9)
Orthopedic disorders	4 (9)
Spinal cord injury	1 (2)
Back disorders	12 (27)
Chronic pain	7 (15)
Whiplash	3 (7)
Unknown	1 (2)

Data Analysis

All data analyses were carried out according to a pre-established analysis plan, using the SPSS 11.0 software program. For the test-retest reliability of the PASIPD the mean difference between the second and first PASIPD measurements and the 95% confidence interval (95% CI) were calculated. Since PASIPD data were not normally distributed, nonparametric Spearman correlation coefficients were calculated for the second and first PASIPD to obtain the test-retest reliability. For the criterion validity, nonparametric Spearman correlation coefficients were calculated for the second

PASIPD and the total counts over the 7 days of the MTI/CSA, and for the second PASIPD and the total vector magnitude counts over the 7 days of the RT3.

Results

Table 1 shows the personal characteristics of the 45 included subjects. Nine of the subjects were still receiving treatment at one of the participating rehabilitation centres. The remainder had finished rehabilitation in the previous two years. Figure 1 shows the scatterplot of the first and second PASIPD assessment. Figure 2 and 3 show the scatterplots of the PASIPD and the MTI/CSA data and of the PASIPD and the RT3, respectively. The RT3 and the first PASIPD measurement were added to the study at a later stage. Hence, for thirteen people these data were not available. Other reasons for missing measurements were logistic problems with the first PASIPD (n=4), the MTI/CSA (n=2) and the RT3 (n=2) respectively, and technical problems with the RT3 (n=8).

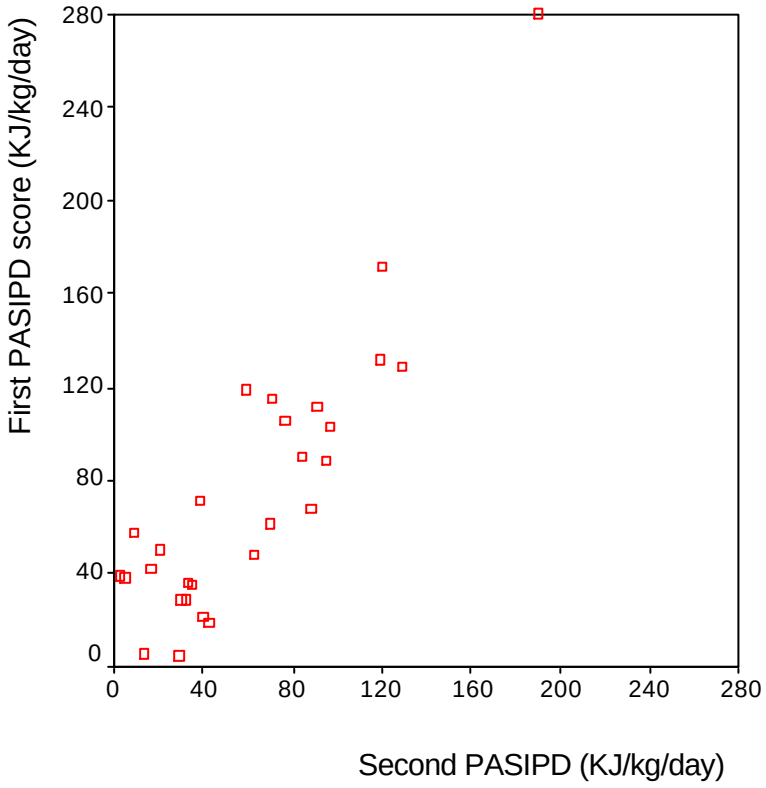

Figure 1: Scatterplot of the first and second PASIPD score (n=28).

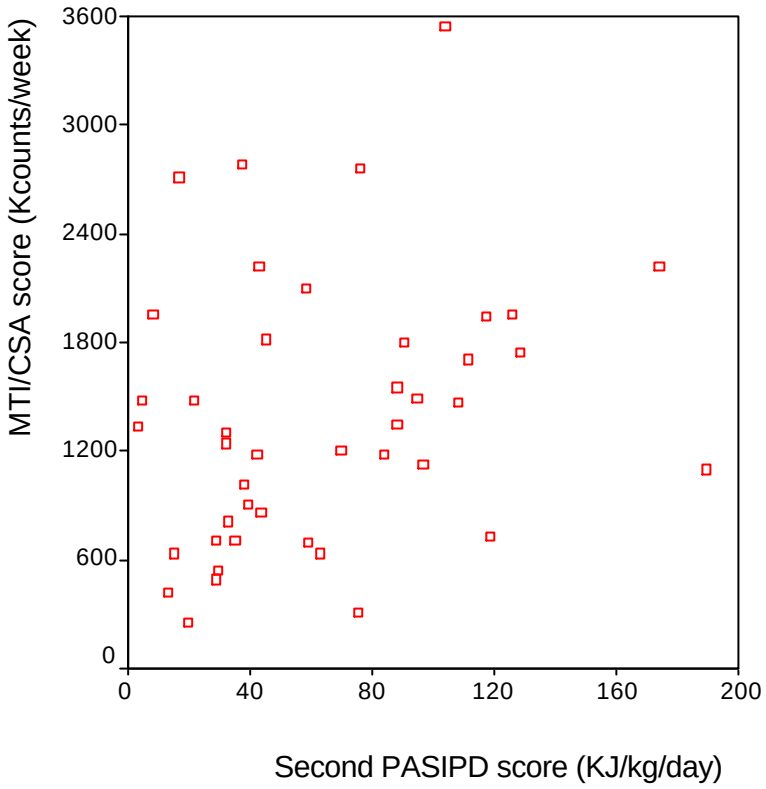

Figure 2: Scatterplot of the MTI/CSA accelerometer and the PASIPD score (n=43).

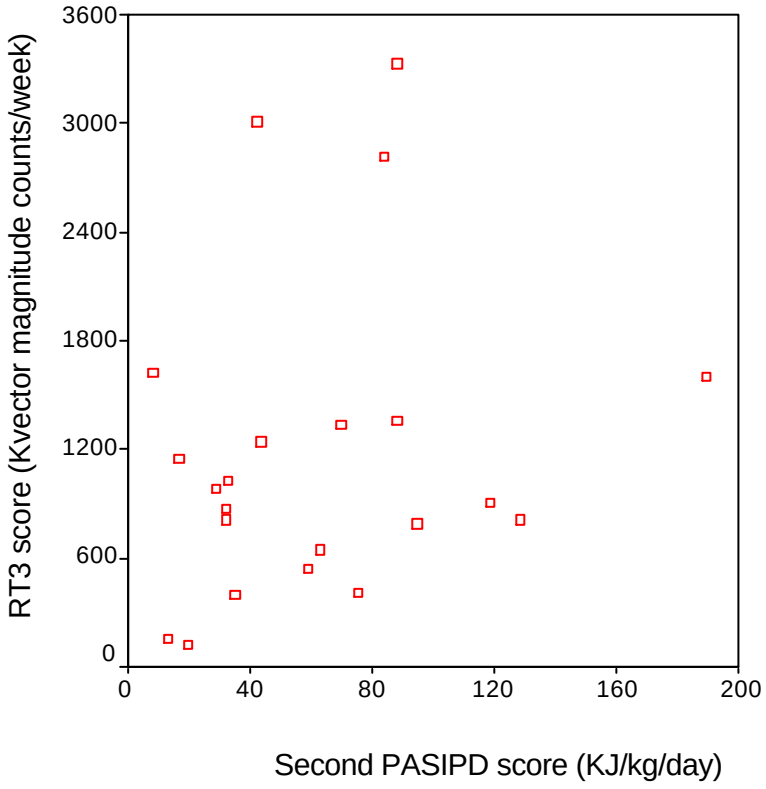

Figure 3: Scatterplot of the RT3 accelerometer and the PASIPD score (n=22).

The outcome measures and results of the analyses are reported in table 2. Table 2 shows a test-retest reliability Spearman correlation coefficient of 0.77. The 95% CI of the difference between the first and second PASIPD (? PASIPD), ranges from -69.9 to 41.5, thus containing zero. The criterion validity Spearman correlations of the PASIPD were 0.30 and 0.23 when compared to the MTI/CSA and to the RT3, respectively.

Table 2: Values of the PASIPD, MTI/CSA and RT3, and the PASIPD test-retest reliability and criterion validity correlation coefficients.

Outcome	**n**	**Mean ± SD**	**95% CI**	**Spearman correlation with second PASIPD**
First PASIPD, $KJ \cdot kg^{-1} \cdot day^{-1}$	28	74.9 ± 58.8		0.77
Second PASIPD, $KJ \cdot kg^{-1} \cdot day^{-1}$	45	65.1 ± 44.6		
? PASIPD, $KJ \cdot kg^{-1} \cdot day^{-1}$	28	-14.2 ± 28.4	-69.9 – 41.5	
MTI/CSA, $Kcounts \cdot week^{-1}$	43	1380 ± 738		0.30
RT3, *Kvector magnitude* $counts \cdot week^{-1}$	22	1175 ± 867		0.23

Discussion

This study on psychometric aspects of the PASIPD questionnaire showed a test-retest reliability Spearman correlation coefficient of 0.77. This reliability measure reflects both measurement error of the PASIPD and true variation in physical activity. Furthermore, this study reported a criterion validity correlation coefficient of the PASIPD of 0.30 when compared to the MTI/CSA and of 0.23 when compared to the RT3. These criterion validity correlation coefficients reflect the validity of the PASIPD as well as of both accelerometers, since none of these three measures are considered the gold standard for physical activity measurement. However, since the PASIPD and the accelerometers measure physical activity in a different way with different kinds of bias, the comparison between these methods does give some indication of their respective validities.

Literature perspective

The results of the current study showed that the test-retest reliability and criterion validity of the PASIPD are comparable to several well established self-report physical activity questionnaires for the healthy population. A recent review of seven self-report physical activity measures in the healthy population reported test-retest reliability correlations ranging from 0.34 up to 0.89, with a median of about 0.80.[13] The International Physical Activity Questionnaire (IPAQ) had a test-retest reliability of about 0.80.[15] The IPAQ was designed by an International Consensus Group, in an effort to standardize physical activity measurement in the healthy population and to improve international comparison between studies.[15] The only other physical activity questionnaire described in the literature and designed specifically for people with disabilities is the Physical Activity and Disability Survey (PADS).[16] A psychometric study of the PADS reported a test-retest intraclass correlation coefficient of 0.85 over an unspecified test-retest time period in a group of 30 subjects, mostly African American overweight women with either stroke or type 2 diabetes.[16]

The review of Sallis and Saelens reported correlations between physical activity questionnaires and accelerometers ranging from 0.14 to 0.53, with a median of about 0.30.[13] The IPAQ reported a correlation of about 0.30 with the MTI/CSA.[15] In a study among 47 COPD outpatients a Pearson correlation of 0.14 between an activity recall questionnaire and Tritrac R3D accelerometer was reported.[17] Another study found Pearson correlations of 0.32 between the 7-day Recall Questionnaire and the Tritrac R3D, in a combined group of 17 multiple sclerosis patients and 15 healthy subjects.[18] For the PADS no data were found for the comparison with another method assessing physical activity behaviour. When compared further to the PASIPD, the PADS does not identify work-related physical activities. The PASIPD also has more subcategories of physical activity than the PADS and uses examples of activities, which could lead to better recall of activities. However, more research is needed for both questionnaires on more similar populations to make an in-depth comparison.

Washburn et al. looked at internal consistency and construct validity of the PASIPD in 372 people with mostly locomotor related disabilities (80%).[14] Factor analysis revealed 5 factors accounting for 63% of total variance: home repair, lawn and garden work; housework; light and moderate sport and recreation; vigorous sport and recreation; and occupation. Cronbach α coefficients for the factors ranged from 0.37

to 0.65. Pearson correlations between each survey item and the total PASIPD score ranged from 0.20 to 0.67. Washburn et al. also provided preliminary support for the construct validity of the PASIPD. People who reported to be active, assessed with a single question, had significantly higher total and subcategory PASIPD scores than 'inactive' people. Furthermore, younger and healthier people scored significantly higher on the PASIPD.[14]

Limitations

As stated earlier, neither the PASIPD nor the accelerometers are a gold standard for the measurement of physical activity behaviour. The most important limitations of physical activity recall questionnaires, like the PASIPD, are social desirability and recall bias.[11-13] Social desirability is probably higher in an interview than in a self administered questionnaire, like the PASIPD. Social desirability was minimized by emphasizing to the participants that the data analysis was anonymous. As discussed in the generalizability section, the problem of recall bias demands sufficient cognitive abilities of the participants, which was one of the inclusion criteria of the current study.

The limitations of accelerometers are well documented.[12,19,20] First, not all physical activity is reflected by accelerations of the body mass, e.g. as static work, cycling on a treadmil, arm ergometry, strength training, or walking on a slope or with a load. Uniaxial accelerometers worn on the hip also underestimate activities with a limited vertical component, such as cycling and rowing. Second, a problem with accelerometers is possible noise in the detection device and the registration of non-human movements. For example the RT3 registers car rides.[20] Third, the activity counts of the MTI/CSA and of the RT3 are not interchangeable and the conversion of activity counts to energy expenditure is not advisable, making a comparison to the energy score of a questionaire more complicated.[19,20] Fourth, problems could exist with the compliance of wearing the accelerometers, for which no data was available in this study.[20] Finally, little is known about the validity of accelerometers in people with disabilities.[14] It is unclear how abnormal or slow gait patterns, for example in stroke patients, influence accelerometer measurements. In a study with seventeen stroke patients with chronic hemiparetic gait, the Caltrac accelerometer and the new SAM accelerometer where compared.[21] The SAM was reported to perform better

than the Caltrac, however, no external validity criterion was used. Haeuber et al. argued that traditional accelerometers, like the Caltrac, CSA and Tritrac R3D, do not account for asymmetries in gait, in contrast to the new SAM accelerometer.[21] Problems with different gait patterns could also be solved by using more complex ambulatory activity monitors that can measure quantity, quality and physical strain of both posture and motion.[22,23] Such ambulatory activity monitors usually combine several accelerometers attached to different locations on the body with electrocardiogram measurement. However, such systems can hinder activities, influence the subjects behaviour and are far more expensive than uniaxial or triaxial accelerometers.

Doubly labeled water is the gold standard for 24h-energy expenditure and would probably be the best method to determine the validity of the PASIPD. Studies comparing doubly labeled water and physical activity questionnaires show higher correlations than studies comparing questionnaires and accelerometers.[12,24] It seems likely that this would also hold for the PASIPD. However, doubly labled water is a complex and expensive method and the validity could be lower in people who have health conditions that affect total body water content.[14]

Generalizability

In the current study wheelchair dependent people were excluded, because the attachement of the accelerometers to the hip would result in incorrect measurement of physical activity. However, the PASIPD is also designed for wheelchair dependent people and includes specific examples of wheelchair activities. Future studies are needed to look at the reliability and validity of the PASIPD for wheelchair dependent people. People with insufficient cognitive abilities were also excluded from the current study. The PASIPD is not applicable to people with cognitive limitations, since a 7-day recall would most likely not lead to an accurate estimation of physical activity. The usefulness of the PASIPD in populations with more psychological related diagnoses is unclear. The low number of subjects in different diagnosis groups makes it impossible to determine from the current data whether the PASIPD is equally useful for different diagnosis groups. More research is needed to determine if the current results can be generalized to different populations of people with physical disabilities.

Conclusion

The current study showed that the PASIPD had test-retest reliability and criterion validity that were comparable to the measurement properties of well established self-report physical activity questionnaires for the healthy population. Although more research is needed to get a better insight in the validity and applicability of the PASIPD, it can be used in monitoring and intervention studies focusing on physical activity behaviour in people with physical disabilities.

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Chapter 4

Correlates of physical activity during outpatient rehabilitation: a study in 1007 people with disabilities

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Abstract

Objectives. To identify correlates of physical activity behaviour in people with a physical disability during outpatient rehabilitation.

Methods. In this cross-sectional study physical activity and correlates of physical activity were measured with questionnaires in subjects (n=1007) from ten Dutch rehabilitation centres, seven weeks before the end of rehabilitation. Data were analysed using multiple linear regression analysis. Most frequent diagnoses were stroke, neurological and back disorders.

Results. Being younger, having children living at home, participating in paid/volunteer work and/or education, smoking, a shorter total treatment period, more sport related activities during the treatment period, higher self efficacy and/or better attitude towards physical activity, experiencing health conditions and lack of energy less frequently as barriers to physical activity behaviour, and lack of time and money, were significantly correlated with self-reported physical activity.

Conclusions. Several correlates of physical activity were identified in our population of people with a physical disability during outpatient rehabilitation. These correlates can be helpful in designing physical activity promotion interventions that are linked to outpatient rehabilitation. However, prospective research during and after outpatient rehabilitation is needed to further increase the knowledge on correlates of physical activity and possible causal relationships in this population.

Introduction

It is well known that a physically active lifestyle is beneficial for the health status of people in the general population.[1-4] Regular physical activity reduces the risk of morbidity and mortality due to numerous chronic diseases, including coronary artery disease, diabetes and colon cancer. These beneficial effects of physical activity are also important for people with a physical disability.[5-10] The World Health Organisation defines disability as problems an individual may experience in functioning.[11] Disabilities are the result of health conditions in the context of the person and his/her environment with health conditions being mainly diseases, disorders, injuries and traumas. Problems with functioning are often related to physical activity. This is probably one of the reasons that people with a disability are in general even less physically active than people in the general population.[12,13] This also implies that increasing physical activity, within the possibilities of each specific individual, could probably improve everyday functioning.

In the coming decades demographic developments will lead to increased numbers of people with a disability with a simultaneous increase in (outpatient) rehabilitation. It is believed that outpatient rehabilitation is an important stage for persons with a disability in order to develop a physically active lifestyle. During outpatient rehabilitation, people live at home and visit the rehabilitation centre for treatment by several different health professionals. Treatment usually includes structured sport related physical activities such as swimming and fitness exercises. Thus, outpatient rehabilitation adds physical activities to daily life. However, after the rehabilitation period the structured physical activities end. Then, people with a disability often become inactive, even though maintaining or increasing the level of physical activity they had during rehabilitation would make everyday functioning easier and reduce the risk of secondary health problems. Consequently, it is important to systematically help people with a disability to establish a physically active lifestyle after outpatient rehabilitation. In order to achieve this, knowledge is needed about the factors that influence a physically active lifestyle. This knowledge can lead to the design of physical activity promotion interventions that target these factors during and after rehabilitation. However, not much is known about the factors influencing physical activity behaviour in people with a disability.[14]

In an earlier paper a literature-based conceptual model on physical activity behaviour, its determinants and functioning in people with a disability was proposed.[15] This model integrated a functioning/disability theory with a physical activity behaviour theory from the general population. In order to acquire a further understanding of the determinants of physical activity in people with a disability we conducted a cross-sectional study. The goal of this study was to identify correlates of physical activity behaviour in people with a physical disability during outpatient rehabilitation.

Methods

Study Subjects

All outpatient subjects over 18 years of age from ten Dutch rehabilitation centres were candidates for inclusion in the study if they had one of the following diagnoses: amputation, stroke, neurological disorders, orthopaedic disorders, spinal cord injury, rheumatic related disorders, back disorders or whiplash. Subjects were excluded if one of the following criteria were met: (A) insufficient cognitive abilities to participate; (B) medical contra-indications for participating; (C) terminal or very progressive disease; (D) insufficient understanding of the Dutch language; (E) no interest at all in sport participation. Of the 3612 subjects who were assessed for eligibility, 2605 had to be excluded. Reasons for exclusion were: did not meet inclusion and/or exclusion criteria (n=1563), refused to participate (n=202), was not timely approached (n=492), and reason unknown (n=348). Written informed consent was obtained from 1007 subjects. In January 2001, the Medical Ethics Committee of Rehabilitation Centre Het Roessingh in Enschede (the Netherlands) approved the study.

Data Collection and Outcome Assessment

The period for inclusion of subjects started March 2001 and lasted until June 2003. Research assistants obtained completed questionnaires from the subjects approximately seven weeks before the end of their outpatient rehabilitation period. Demographic data were recorded using questionnaires. Body mass index was calculated from self-reported body height and weight. At the end of rehabilitation the total duration of treatment and total hours of sport related physical activities during

treatment were obtained from a computerized registration system of each rehabilitation centre.

Physical activity was measured with the Physical Activity Scale for Individuals with Physical Disabilities (PASIPD).[16] This 7-day recall questionnaire consists of questions on leisure time, household and work-related physical activities. We translated the PASIPD into Dutch and integrated question 10 and 11 of the original questionnaire into a single question, since this better represents the Dutch situation. This made the Dutch PASIPD a 12-item questionnaire (Cronbach α = 0.6), from which a total physical activity score ($KJ \cdot kg^{-1} \cdot day^{-1}$) was calculated. If only one item of the PASIPD was missing for a subject (n=33), imputation was performed using the most conservative value (least physically active option) of the missing item to calculate a total physical activity score.

Since not much is known about correlates of physical activity in people with a disability, the selection of the correlates included in the questionnaire was mostly based on literature concerning the general population.[17-21] The following correlates of physical activity were measured using Dutch versions of existing questionnaires: attitude towards physical activity,[22] self-efficacy towards physical activity,[23] social influence from family and friends concerning physical activity,[22] barriers to physical activity,[24] and perceived benefits of physical activity.[24] From the extensive questionnaire of Sallis et al.[24] seven important barriers to physical activity and six perceived benefits were selected. The barriers included: lack of money, lack of time, lack of energy, lack of motivation, limited possibilities in the person's environment, transportation problems, and the person's health conditions (i.e. diseases, disorders, injuries and/or traumas). The perceived benefits of regular physical activity included: improved health and reduced risk of disease, better feeling about oneself, improved fitness, improved daily functioning, weight loss, and meeting new people.[24] All correlates were scored on a 1-5 Likert-type scale, except self efficacy (0-10 scale). For self-efficacy, attitude, social influence, and perceived benefits a higher score means a more positive value for this variable with respect to a physically active lifestyle. For example, a score of "one" on the attitude scale means that the subject thought that a physically active lifestyle was "very bad" for him or herself, and a score of "five" means that he or she thought this was "very good". For the barriers to physical activity a score of "one" means that the subject "never" experienced this barrier, while a "five" means the subject experienced it "very often".

Data Analysis

Multiple linear regression analysis was performed, using SPSS (version 10.1) software, to find out which measured correlates of physical activity significantly predicted the total PASIPD score. Since the PASIPD score was not normally distributed, the following transformation was used for our analysis: "Ln(total PASIPD score + 1)". For the linear regression analysis a backwards method was used, starting with all variables in the regression model. Subsequently, one by one the least significant variable was removed, until only significant variables ($p<0.05$) were left in the regression model. The regression analysis started with the following independent variables: attitude, self-efficacy, social influence from family and from friends, the seven barriers to physical activity, the six benefits of physical activity, age, gender, body mass index, diagnosis, time since start of complaints, duration of treatment, hours of sport related physical activities during treatment, education, monthly income, marital status, children living at home, smoking, sport in year before rehabilitation, time of measurement (season: winter, spring, summer and autumn), and participation in paid/volunteer work and/or education. Beta and p-value were reported for each significant correlate in the final regression model, as well as the variance explained by the model (R^2). A correlation matrix for the variables that were included in the model and those not included was checked to find possible multi co-linearity problems.

Results

The demographic data of the population are shown in table 1. For having children living at home and smoking, 'yes' was coded as 'one' and 'no' as 'two'. 'Participating in paid/volunteer work and/or education' was coded as 'two' and 'not participating' as 'one'.

Table 2 shows the mean scores on the PASIPD and correlates of physical activity. The scores for attitude, social influence and perceived benefits were high, suggesting that our population and the people surrounding them perceived a physically active lifestyle as positive. The most frequent barriers to physical activity in our population were the persons' health conditions and lack of energy. The other barriers had low scores, meaning our subjects seldom experienced these barriers.

Table 1: Demographic data.

Variable	Men (n=516)	Women (n=491)	Total (n=1007)	n
Mean age ± SD (y)	48 ± 13	43 ± 13	46 ± 14	1006
Mean body mass index ± SD ($kg \cdot m^{-2}$)	25.8 ± 4.0	25.2 ± 5.3	25.5 ± 4.7	996
Having children living at home (n (%))	200 (39)	198 (41)	398 (40)	1000
Smokers (n (%))	159 (31)	161 (33)	320 (32)	1004
Participating in paid/volunteer work and/or education (n (%))	246 (48)	304 (62)	550 (55)	1007
Mean duration of treatment ± SD (h)	126 ± 165	98 ± 110	112 ± 141	935
Mean total time of sport related activities during treatment ± SD (h)	32 ± 48	22 ± 36	27 ± 43	928
Diagnosis group (n (%))				1006
Amputation	50 (10)	17 (4)	67 (7)	
Stroke	173 (34)	80 (16)	253 (25)	
Neurological disorders	82 (16)	75 (15)	157 (16)	
Orthopaedic disorders	53 (10)	41 (8)	94 (9)	
Spinal cord injury	36 (7)	9 (2)	45 (5)	
Rheumatic related disorders	41 (8)	61 (13)	102 (10)	
Back disorders	61 (12)	86 (18)	147 (15)	
Chronic pain / whiplash	15 (3)	118 (24)	133 (13)	

The results of the multiple linear regression analysis are given in table 3. The results show that a higher PASIPD score was significantly correlated with being younger, having children living at home, participating in paid/volunteer work and/or education, smoking, a shorter total treatment period, more sport related activities during the treatment period, higher self efficacy, better attitude, experiencing health conditions and lack of energy less frequently as barriers, and lack of time and money. These correlates explained 21.1% of the variance (R^2=0.211) in the self-reported physical activity score. The correlate with the highest beta, the barrier lack of energy, was the strongest predictor of self-reported physical activity. The beta also shows the direction of the relationship between the correlate and physical activity. For example, people who experienced lack of energy were on average less physically active and people with a higher self-efficacy were on average more physically active.

Table 2: Self-reported physical activity level and correlates of physical activity.

Variable	Mean measured values ± SD			
	Men	Women	Total	n
PASIPD score ($KJ \cdot kg^{-1} \cdot day^{-1}$)	69.1 ± 59.8	59.9 ± 47.4	64.6 ± 54.2	999
Transformed PASIPD	3.9 ± 0.9	3.8 ± 0.8	3.9 ± 0.9	999
Self-efficacy	5.5 ± 1.9	5.2 ± 2.0	5.3 ± 2.0	993
Attitude	4.2 ± 0.9	4.3 ± 0.9	4.3 ± 0.9	1005
Social influence family	4.3 ± 0.9	4.3 ± 1.0	4.3 ± 1.0	988
Social influence friends	4.2 ± 0.9	4.2 ± 1.0	4.2 ± 1.0	969
Perceived benefits of physical activity				
Improve health, reduce risk on disease	3.9 ± 1.1	3.7 ± 1.1	3.8 ± 1.1	997
Feeling better over oneself	4.1 ± 0.9	4.1 ± 0.8	4.1 ± 0.9	1002
Become more fit	4.2 ± 0.9	4.2 ± 0.8	4.2 ± 0.8	1001
Better daily functioning	4.0 ± 0.9	3.9 ± 0.8	3.9 ± 0.9	1002
Lose weight	3.4 ± 1.2	3.3 ± 1.2	3.3 ± 1.2	996
Meet new people	3.5 ± 1.0	3.7 ± 1.0	3.6 ± 1.0	999
Barriers to physical activity				
Health conditions	3.5 ± 1.1	3.9 ± 1.0	3.7 ± 1.1	996
Limited environmental possibilities	2.5 ± 1.2	2.6 ± 1.3	2.5 ± 1.2	985
Lack of time	2.2 ± 1.0	2.3 ± 1.0	2.2 ± 1.0	984
Lack of motivation	2.2 ± 1.0	2.3 ± 1.0	2.3 ± 1.0	992
Lack of money	1.8 ± 1.1	1.9 ± 1.1	1.8 ± 1.1	988
Lack of energy	2.7 ± 1.2	3.4 ± 1.1	3.1 ± 1.2	993
Transportation problems	1.9 ± 1.2	2.0 ± 1.3	2.0 ± 1.2	984

Table 3: Linear regression model predicting self-reported physical activity level during outpatient rehabilitation (n=872).

Correlate	Beta	p-value	R^2
Age	-0.12	<0.01	
Self-efficacy	0.10	<0.01	
Attitude	0.12	<0.01	
Children living at home	-0.11	<0.01	
Smoking	-0.10	<0.01	
Participating in paid/volunteer work and/or education	0.13	<0.01	
Duration of treatment	-0.14	<0.01	
Duration of sport activities during treatment	0.10	0.026	
Barriers to physical activity			
Health conditions	-0.12	<0.01	
Lack of time	0.09	<0.01	
Lack of money	0.07	0.036	
Lack of energy	-0.19	<0.01	
			0.211

Discussion

The goal of this cross-sectional study was to identify correlates of physical activity behaviour in people with a physical disability during outpatient rehabilitation. The results showed that being younger, having children living at home, participating in paid/volunteer work and/or education, smoking, a shorter total treatment period, more sport related activities during the treatment period, higher self efficacy and/or better attitude towards physical activity, experiencing health conditions and lack of energy less frequently as barriers to physical activity behaviour, and lack of time and money were significantly correlated with a higher PASIPD score in people with a physical disability during outpatient rehabilitation. Altogether, these correlates explained 21.1% of the variance in self-reported physical activity.

The relations between the correlates age, self-efficacy, and attitude with physical activity behaviour were also reported in literature reviews focussing on the general adult population.[18,25-27] Self-efficacy was also reported to significantly predict maintenance of exercise in people with mobility impairments.[21] Attitude was a stronger predictor of physical activity behaviour in our study than in the general population.[18,25-27] Even though the average attitude score we found was similar to the

score reported by a study in people without a disability that used the same questionnaire.[22]

The barriers health conditions and lack of energy seem to be more specific to people with a disability and were reported as correlates of physical activity behaviour in the few studies in this population.[19-21] Correlates specific for outpatient rehabilitation were total duration of treatment and the amount of sport related activities during treatment. The negative association between duration of treatment and physical activity most likely reflects the fact that people with more severe health conditions needed longer rehabilitation and for the same reason were less physically active. The obvious explanation for the finding that people who received more sport related physical activities during their outpatient rehabilitation were more physically active was that these activities were part of the physical activities as assessed by the PASIPD. It is also possible that these structured activities carried over into everyday life and, consequently, made people even more physically active.

Lack of time and money appear to be barriers to physical activity in the general population[18,27] as well as in people with disabilities.[19,21] Although in the present study lack of time and money were the least strong predictors of physical activity, both were unexpectedly found to be facilitators of physical activity behaviour. However, around 90% of the subjects never to sometimes (scores from 1 to 3) experienced lack of money or time in relation to physical activity, maybe because rehabilitation often included sport related activities. A possible explanation for the observed associations was that the more active subjects already spend more time and money on physical activity, and consequently both variables became a barrier when trying to spend even more money or time on a more physically active lifestyle. Given the above discussion, it seems likely that lack of money and time do not play an important role in physical activity behaviour during outpatient rehabilitation.

Literature reviews showed that there is weak or mixed evidence for a positive association between being childless and physical activity in the general population.[18,25,27] This finding contrasts with our study, which showed a positive association between having children living at home and physical activity. Maybe taking care of a child increases physical activity behaviour, even though parents consequently have less time to spend on other physical activities. It seems logical that taking care of a child also remains a high priority for people with a disability

during outpatient rehabilitation, while other physical activities may become less important.

The current study found participating in paid/volunteer work and/or education to correlate with self-reported physical activity. Interpretation of the causal nature of this relationship is difficult. Were the more physically active people able to participate in work or education, or were the working and studying people more physically active? However, this finding might suggest that two important goals for people with a disability, improving physical activity behaviour and participation in society, go well together.

Literature reviews reported that smoking had a negative to no association with physical activity in the general population.[18,27] Surprisingly, our study found a positive association between smoking and physical activity, which seems hard to explain. Maybe the less active people were the less healthy, which may have made them more aware that smoking is bad for them and which may have made them experience the negative consequences of smoking. Thus the subjects, who are still healthy enough, might continue to smoke and be active. While people who lost their ability to be mobile might not be healthy enough to keep smoking. Anyway, to us it seems unlikely that smoking will increase physical activity behaviour and obviously smoking behaviour should not be promoted.

Our observed prediction model of self-reported physical activity in people with a disability during outpatient rehabilitation had an R^2 of 0.211. Biddle et al. reported an R^2 in a cross-sectional study of 0.32 and 0.38 for women and men, respectively; in a university workforce sample (n=131) when predicting self-reported strenuous physical activity.[22] The correlates used in their model were intention, attitude, social norm, perceived control, barriers, benefits, and self-efficacy. However, in women only intention added significantly to their model and in men only intention and attitude. Intention is thought to be the correlate closest to the actual physical activity behaviour,[15] and explained by far the largest proportion of variance in the study of Biddle et al. (0.17 in women and 0.21 in men).[22] Consequently, the higher R^2 in the study of Biddle et al. could be explained by the use of intention in their prediction model. Furthermore, in their study the population and main outcome were different, making a direct comparison difficult.

Excluded Variables

Gender, education, monthly income, marital status, sport history, social influence and the remainder of the barriers and the facilitators of physical activity behaviour are known correlates of physical activity in the general population,[17,18,25-27] but did not add significantly to our prediction model. Besides these variables, we also hypothesized that time since start of complaints, diagnosis group, and body mass index might be correlates of physical activity in people with a disability during outpatient rehabilitation. The absence of some of these variables in our prediction model will be discussed below.

In the general population social support (similar to social influence), especially from friends and family, is known to be a prominent correlate of physical activity behaviour.[18,25-27] A likely explanation for the lack of correlation for this variable in our model is the following. The social support scores in our population were higher (4.3 and 4.2) than in an university workforce sample (3.1), which used the total score of the same questionnaire.[22] Our study found that only around 6% of the subjects scored less than a three on both five point scales, and more than 80% scored a four or higher. This shows that social influence was high in most subjects of our population, making it difficult to differentiate between the physically inactive and the more active, based on social influence. Consequently, social influence did not add to our prediction model. During outpatient rehabilitation, the medical professionals treating the patient are probably important when it comes to social influence. During rehabilitation, medical professionals often give the patient advice about everyday functioning, which can include advice on physical activity. Literature reviews in the general population repeatedly documented that physician influence had a positive association with physical activity.[18,27] This suggests that social influence from medical professionals should be measured in future studies focussing on outpatient rehabilitation.

Lack of motivation, limited possibilities in the persons environment and transportation problems have frequently been reported to be barriers to physical activity in the general population.[17,18,25-27] In African American women with physical disabilities 61% and 41% reported lack of transportation and lack of motivation as barriers to exercise, respectively.[19] In people with a mobility impairment lack of accessible facilities was reported as an external barrier to maintenance of exercise.[21]

However, the results of our linear regression analysis and the low average scores of these three variables suggest that they were not barriers to physical activity behaviour during outpatient rehabilitation. This was probably caused by the sport related activities during rehabilitation, which often also included organised transportation, reducing the need to look for other structured sport and exercise possibilities. Furthermore, general daily physical activities are probably less sensitive to these barriers. Literature reviews in the general population have shown perceived benefits to be positively associated with physical activity.[18,27] However, in our population these benefits appeared not to be correlates of physical activity behaviour. Again, the on average high scores in our population made it difficult to differentiate between the physically inactive and the more active.

Limitations and Recommendations

This study has certain limitations. Firstly, the inability to define cause and effect in cross-sectional studies should be taken into account.[28] For example, one may question whether subjects were more physically active because of high self-efficacy, or whether they had high self-efficacy because they were more physically active. Thus, this study looked for correlates of physical activity behaviour, which does not necessarily implies a cause and effect relationship, and was unable to look for determinants of physical activity.[28] Secondly, the used self-report questionnaires bring along possible information bias (e.g. recall bias) leading to the relative low explained variance. Although the PASIPD was developed for this specific population, the questionnaires of the correlates of physical activity were originally designed for the general population. Thirdly, our population was very heterogeneous and correlates of physical activity may differ between different subgroups of people with a disability. Fourthly, the population of people with a disability during outpatient rehabilitation is very specific, which together with possible selection bias makes generalization of the results to the whole population of people with a disability difficult.

Given these limitations, it does not seem appropriate to neglect the correlates of physical activity that did not add significantly to the reported prediction model of physical activity behaviour. Much is still unclear concerning correlates of physical activity in people with a disability, especially those who do not follow a rehabilitation

program. It seems likely that the outpatient rehabilitation program and specifically sport related activities reduced several barriers to physical activity and had a positive influence on several correlates, leading to high scores on social influence, and benefits to physical activity. It remains to be seen how the end of the outpatient rehabilitation will influence these correlates. Consequently, research linking correlates of physical activity during rehabilitation to those after rehabilitation is needed to design effective physical activity promotion interventions, which preferably should start during rehabilitation and continue after the end of rehabilitation. From the current study the following recommendations concerning the use of the correlates of physical activity identified during outpatient rehabilitation for such interventions can be made. Firstly, age and having children living at home cannot be targeted by a physical activity promotion program. Secondly, even if our unlikely finding was correct and smoking increases physical activity behaviour, smoking behaviour should be discouraged due to its known hazardous health effects. Thirdly, the average scores on the attitude questionnaire were already high, with more than half of the subjects scoring the maximum. Consequently, it seems that a physical activity promotion program should focus on maintaining rather than improving attitude after the end of outpatient rehabilitation. This advice could probably also hold for the correlates that had high scores, but did not add significantly to the prediction model. Fourthly, our study suggests that strategies to increase self-efficacy might increase physical activity behaviour in people with a disability. Fifthly, promotion of participation in work or education seems advisable, but the question remains whether an increase in physical activity behaviour will be a direct effect, or merely a cause. Sixthly, the relationship between physical activity and the barriers health conditions and lack of energy could be similar. Reducing these two barriers is likely to increase physical activity behaviour, but on the other hand improvement of certain health conditions and the amount of experienced energy might be obtained by becoming more physically active. Seventhly, lack of money and time are probably not very important barriers to physical activity during outpatient rehabilitation, and including these correlates in a physical activity promotion program focusing on the earlier mentioned unexpected direction of the relationship with physical activity does not seem wise. Finally, the duration of treatment is most likely a proxy for severity of the health conditions and should not be the target of an intervention. However, increasing the amount of sport related physical activities during treatment could

easily be part of an intervention. Future research has to show if this strategy also leads to increased physical activity behaviour after conclusion of outpatient rehabilitation.

In conclusion, this study identified several correlates of physical activity in people with a physical disability during outpatient rehabilitation. This new information is important to design interventions linked to outpatient rehabilitation to improve physical activity behaviour in the physically inactive population of people with a disability. However, prospective research during and after outpatient rehabilitation is needed to further increase the knowledge on correlates of physical activity and possible causal relationships in this population.

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Chapter 5

Counselling improves physical activity behaviour nine weeks after rehabilitation

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Abstract

Objectives. To determine the effects of the sport stimulation program 'Rehabilitation & Sports' (R&S) and R&S combined with the daily physical activity promotion program 'Active after Rehabilitation' (AaR) on sport participation and daily physical activity behaviour, nine weeks after in- or outpatient rehabilitation.

Methods. Subjects in four intervention rehabilitation centres were randomised into a group receiving R&S only (n=315) and a group receiving both R&S and AaR (n=284). Subjects in six control rehabilitation centres (n=603) received usual care. Most frequent diagnoses were stroke, neurological disorders and back disorders. Two sport and two daily physical activity outcomes were assessed with questionnaires seven weeks before and nine weeks after the end of rehabilitation. Data were analysed by intention to treat and by on treatment multilevel analyses, comparing both intervention groups to the control group.

Results. R&S showed no significant change. Intention to treat analyses in the R&S + AaR group showed significant improvements in one sport ($p=0.02$) and one physical activity outcome ($p=0.03$). On treatment analyses in the R&S + AaR group showed significant improvements in both sport outcomes ($p<0.01$ and $p=0.02$) and one physical activity outcome ($p<0.01$).

Conclusions. Only the combination of R&S and AaR improved sports participation and daily physical activity behaviour, nine weeks after the end of in- or outpatient rehabilitation.

Introduction

The health benefits of a physically active lifestyle are well known in the general population.[1-5] Such a lifestyle is accompanied by lower risks for morbidity and mortality of a great number of chronic diseases, such as coronary artery disease, diabetes and colon cancer. For people with a physical disability a physically active lifestyle could improve every day functioning, reduce disability and reduce the risk of secondary health problems.[6-11] However, people with a disability are in general less physically active than the general population.[12,13] The World Health Organization (WHO) defines disability as problems an individual may experience in functioning.[14] The relation between functioning, disability, physical activity and determinants of physical activity is described in more detail in the 'Physical Activity for people with a Disability model',[15] which formed the theoretical basis of this study.

In 1997, only 12% of US adults with a disability aged =18 participated in moderate physical activity for at least 30 minutes per occasion for =5 days/week, compared to 16% of people without a disability.[12,13] For leisure time physical activity the difference between people with and without disabilities is even larger; 56% and 36% respectively did not engage in leisure time physical activity.[12,13] Consequently, getting people with disabilities more physically active is probably even more important than it already is for the general population.

For two reasons rehabilitation is an excellent opportunity to start promoting a physically active lifestyle. First, for many people rehabilitation is the start of learning to live with a disability. It might thus be an effective strategy, to integrate physical activity into the new everyday routine following rehabilitation. Second, during rehabilitation sport and other physical activities are often a component of the treatment programs. Integrating these activities directly into everyday life is probably easier to accomplish than trying to become physically active when being sedentary. One of the problems with converting rehabilitation physical activities into daily life is the usual lack of sufficient care, just after rehabilitation. This is why two physical activity promotion programs were developed that targeted rehabilitation patients just before and just after the end of rehabilitation. The first program is a personalized, tailored counselling sport stimulation program called 'Rehabilitation & Sports' (R&S). The second personalized tailored counselling program is 'Active after Rehabilitation' (AaR) and promotes daily physical activity in general. Since no data exists on the

effectiveness of these programs the objective of this study is to determine the effects of the R&S program and the effects of the R&S program combined with the AaR program, on sports participation and daily physical activity behaviour in people, nine weeks after conclusion of their in- or outpatient rehabilitation period.

Methods

Study Subjects

All in- or outpatients over 18 years of age from ten Dutch rehabilitation centres were candidates for inclusion in the study if they had one of the following diagnosis: amputation, stroke, neurological disorders, orthopaedic disorders, spinal cord injury, rheumatic related disorders, back disorders or whiplash. Patients were excluded if one of the following criteria were met: (A) insufficient cognitive abilities to participate; (B) medical contra-indications for participating; (C) terminal or very progressive disease; (D) insufficient understanding of the Dutch language; (E) no interest at all in sport participation. Potential participants were identified by health care professionals in the rehabilitation centres and included by the research assistant at the centre, who gave oral information and obtained written informed consent. In January 2001, the Medical Ethics Committee of Rehabilitation Centre Het Roessingh in Enschede (the Netherlands) approved the study.

Study Design

The study included four intervention rehabilitation centres, in which the R&S intervention program already existed, and six control rehabilitation centres. Subjects in the control centres received usual care. Subjects in the intervention centres were randomised into a group receiving R&S only, and a group receiving both the R&S and AaR intervention programs. Randomisation envelopes were made for each intervention centre separately by an independent supervising researcher. After baseline measurements were completed, a research assistant sent every subject to an intervention counsellor with a sealed randomisation envelope, where it was opened. Consequently, research assistants in direct contact with the subjects were blinded to which intervention group the subjects were allocated.

Interventions

The R&S program aimed at improving sport participation after rehabilitation and consisted of two structured counselling sessions with a sport counsellor. The first R&S session occurred approximately six weeks before the end of rehabilitation in the rehabilitation centre and lasted approximately 30 min. Sport history, wishes, possibilities, facilitators and barriers were identified, using a personalized registration form. This resulted in a tailored sport advice from the sport counsellor, including information on available and appropriate sports locations near the subject's home such as a fitness club or swimming pool. Recommended sports were usually non-competitive and most commonly consisted of swimming activities, exercising at a fitness club or exercising in a diagnosis-specific group. The second session was a ten minute telephone check up six weeks after the end of rehabilitation by means of a short questionnaire, which identified sporting status, satisfaction with the given advice and reasons for not participating in sports. If necessary, the sport counsellor gave additional advice.

The AaR program, which was newly developed, aimed at improving daily physical activity in general after rehabilitation and was based on the stages of change concept of the Transtheoretical model.[16] This concept divides subjects into the precontemplation, contemplation, preparation, action and maintenance stages of physical activity behaviour change.[16] Subjects received four sessions with a physical activity counsellor. The first AaR session was six weeks before the end of rehabilitation at the rehabilitation centre and lasted 40 min. Possibilities, facilitators and barriers of daily physical activity were identified, leading to tailored physical activity advice. Additionally, subjects received an information package including a folder on physical activity from the Dutch Heart Foundation, an empty booklet to start a physical activity diary, a list of possible activities with their energy costs and the basic AaR folder. The basic AaR folder was discussed during the first session and contained information on the benefits of a physically active lifestyle, on stages of physical activity change and on tactics to become more physically active. Furthermore, for each subject the stage of physical activity change was assessed using a questionnaire,[17] after which subjects received a stage-specific folder with assignments and tips to become more physically active. This included for example goal setting, rewarding, obtaining social support, and relapse prevention. All folders

were based on materials from Health Partners & Io Solutions, Ltd. (Minneapolis, US) and were translated and adjusted for the Dutch population of rehabilitating patients by an expert panel. Three other 15-20 min counselling sessions were by telephone at two, five and eight weeks after the end of rehabilitation. All three sessions consisted of identifying physical activity status, usage of folders, and possible barriers. Furthermore, attention was paid to possible solutions for barriers and to new physical activity possibilities. Stage of physical activity change was also assessed at all three sessions and subjects who had moved to another stage received the folder specific to the current stage. During all sessions the counsellors used an individual registration form for stages of change, facilitators and barriers, the usage of folders and additional information.

Data Collection and Outcome Assessment

Data collection took place from March 2001 until June 2004. At seven weeks before the end of rehabilitation (T=0), baseline questionnaires were administered under the supervision of a research assistant at the rehabilitation centre. Nine weeks after rehabilitation (T=1) subjects completed the same questionnaires at home.

At T=0 personal characteristics were assessed using questionnaires and included age, gender, self-reported body height and body weight, diagnosis, time since start of complaints, treatment form, marital status, having children living at home, education and monthly income. Body mass index was calculated from self-reported body height and body weight. At T=1 duration of treatment and hours of sport during treatment were obtained from a computerized registration system of each rehabilitation centre.

Two sport participation and two daily physical activity outcomes were assessed at T=0 and T=1 using questionnaires. The first sport participation outcome measure was whether or not subjects participated in sport at that moment (yes/no). Furthermore, the kinds of sport, the average number of hours spent on each sport per week and the self reported intensity was recorded. Every sport was allocated to an intensity category using the physical activity compendium.[18] The intensity categories were: 1-3 metabolic equivalents (MET; 1 MET = 4.184 KJ·kg body weight^{-1}·h^{-1}), 3-6 MET, 6-9 MET, and 9-12 MET. Activities in these categories were given average intensity scores of 1.5, 4.5, 7.5, and 10.5 MET, respectively. The second sport participation outcome was a total sport score expressed in KJ·kg body weight^{-}

$^{1}\cdot day^{-1}$, which was calculated from the intensity category and average time per week for each sport. For both sport participation outcomes at T=0 recall of sport participation during the average week in the year before rehabilitation was recorded.

Daily physical activity was assessed using two outcome measures. The first outcome was whether or not the participants met the recommendation of being moderately physically active at least five days a week for 30 minutes per day, either continuously or intermittently in intervals of at least 5 minutes.[3] This was measured using a stages of change questionnaire.[17] Subjects in the action and maintenance stages were regarded as meeting the recommendation, whereas subjects in the precontemplation, contemplation and preparation stages were not meeting the recommendation. The second outcome was the Physical Activity Scale for Individuals with Physical Disabilities (PASIPD).[19] The Dutch version of the PASIPD is a 12-item 7-day recall questionnaire that consists of questions on leisure time, household and work-related physical activities (Cronbach α = 0.60), from which a total physical activity score in KJ·kg body weight$^{-1}\cdot day^{-1}$ was calculated. If only one item of the PASIPD was missing for a subject, imputation was performed using the most conservative value (least physically active option) of the missing item to calculate a total physical activity score.

Statistical Analyses

Data analysis was performed in July and August 2004 according to a pre-established analysis plan. For all sport and physical activity outcomes measured at T=1 a multilevel analysis comparing both intervention groups to the control group was conducted.[20,21] Multilevel analysis was used, because patient data could be clustered within rehabilitation centres. To correct for differences at baseline between the groups, in all analyses a correction was used for the value of the particular outcome variable at T=0. For the two dichotomous outcomes, i.e. sport participation and meeting the physical activity recommendation, a binominal second order penalized quasi likelihood multilevel analysis was performed. For all multilevel analyses the MLwiN (version 1.1, Institute of Education, London, UK, 2001) statistical computer program was used.

In all analyses, possible confounding effects of age, gender, time between T=0 and end of rehabilitation, time between end of rehabilitation and T=1, time since start of

complaints, duration of treatment, hours of sport participation during treatment, T=0 body mass index, diagnosis, treatment form (in-, outpatient, or both), sport participation and sport score in the year before rehabilitation, marital status, having children living at home, education, monthly income, and the season of measurement was evaluated. Variables that changed the intervention regression coefficients by at least ten percent were identified as confounders and were corrected for in the final analysis. Interaction terms between age or gender and the two intervention variables were also added to investigate possible effect modification ($p<0.05$).

Besides intention to treat analyses, on treatment analyses were performed, in which only the people who actually received their intervention were compared to the control group. For the on treatment analyses the following definitions were used. The R&S on treatment group contained all subjects who received at least the first session between T=0 and T=1, and the time between the second session and T=1 was not longer than 120 days (because only short term effects were studied). The R&S + AaR group contained all subjects who received at least the first two AaR sessions between T=0 and T=1, and the time between the last given session and T=1 was not longer than 120 days. In all analyses p-values smaller than 0.05 were considered statistically significant.

Results

Figure 1 shows the flow of participants through the study. In one intervention centre, the last 18 subjects were not randomised, but had to be allocated to the R&S group because there was no AaR counsellor available anymore in that centre. This accounts for the lower number of subjects in the R&S + AaR group (n=284) compared to the R&S group (n=315). Fifty-five subjects in the R&S on treatment group (39%) received the check up telephone call before T=1. Seventy-five subjects (59%) in the R&S + AaR on treatment group would have met the on treatment rules of the R&S group. Furthermore, in the R&S + AaR on treatment group 34 (27%), 49 (38%), and 44 (35%) received two, three, and four AaR sessions before T=1, respectively. Thirty-two subjects in the R&S + AaR on treatment group (25%) received both the first R&S session and all four AaR sessions.

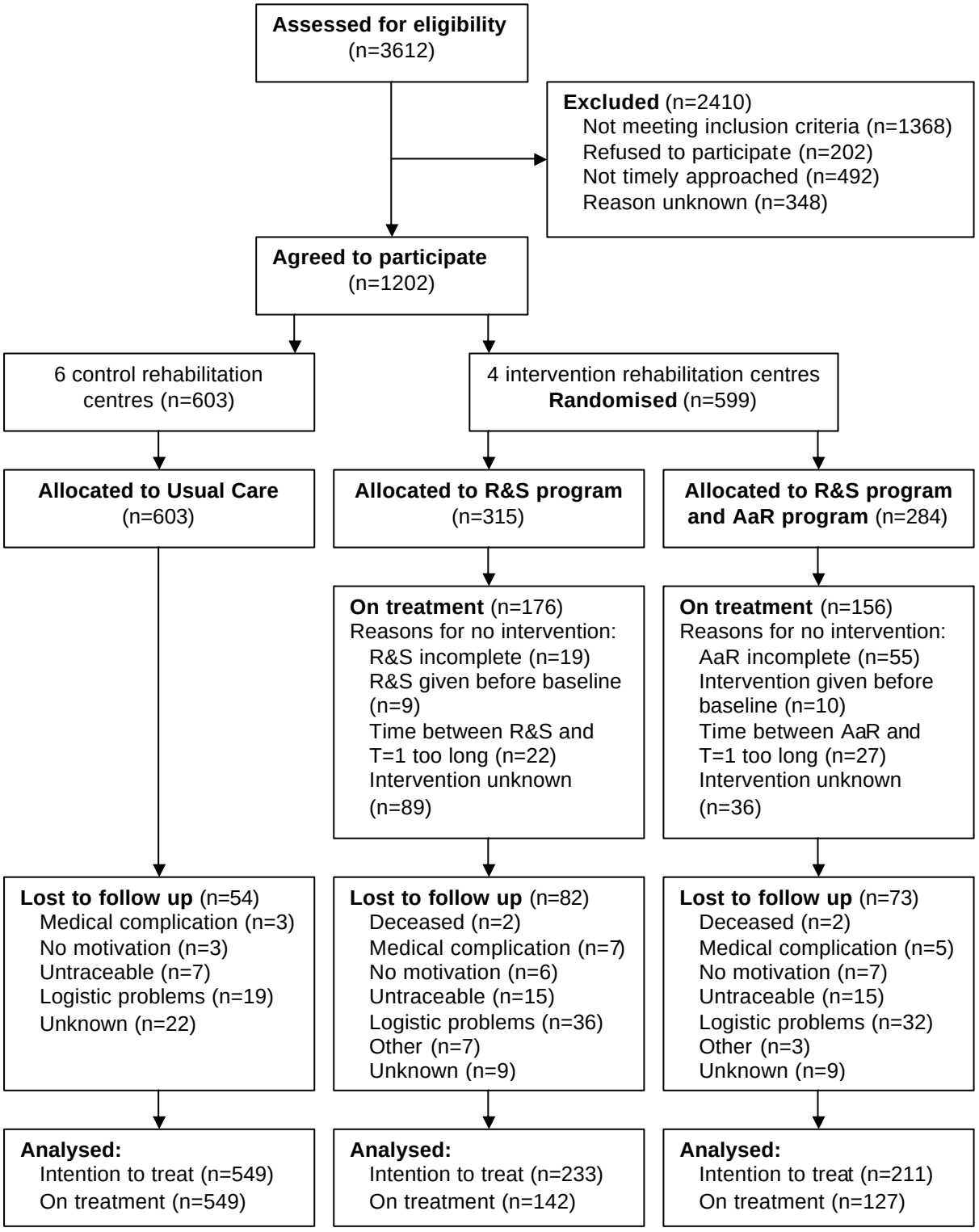

Figure 1: Flow of participants through the study.

Table 1: Personal characteristics of the subjects in all three groups.

Characteristic	**Control (n=549)**	**R&S (n=233)**	**R&S + AaR (n=211)**
Gender male, *n (%)*	280 (51)	122 (52)	111 (53)
Mean age ± SD, *y*	46 ± 14	47 ± 14	47 ± 13
Mean body mass index ± SD, $kg \cdot m^{-2}$	25.7 ± 5.0	25.3 ± 4.3	25.1 ± 4.1
Treatment form, *n (%)*			
Inpatient	15 (3)	61 (27)	52 (25)
Outpatient, first inpatient	133 (24)	70 (31)	52 (25)
Outpatient	398 (73)	97 (42)	104 (50)
Mean duration of treatment ± SD, *h*	84 ± 89	167 ± 159	176 ± 194
Mean time between T=0 and end of rehabilitation ± SD, *days*	71 ± 71	103 ±106	117 ± 118
Education, *n (%)*			
Primary school	59 (11)	15 (7)	15 (7)
Secondary school low	226 (41)	103 (44)	70 (33)
Secondary school high / College low	156 (28)	68 (29)	81 (39)
College high / University	107 (20)	47 (20)	44 (21)
Diagnosis group, *n (%)*			
Amputation	28 (5)	18 (8)	18 (9)
Stroke	155 (29)	58 (25)	43 (21)
Neurological disorders	99 (18)	38 (16)	26 (12)
Orthopaedic disorders	55 (10)	15 (7)	17 (8)
Spinal cord injury	18 (3)	21 (9)	23 (11)
Rheumatic related disorders	42 (8)	14 (6)	23 (11)
Back disorders	87 (16)	30 (13)	21 (10)
Chronic pain / whiplash	60 (11)	38 (16)	37 (18)

R&S, rehabilitation and sport intervention; AaR, active after rehabilitation intervention; SD, standard deviation; T=0, baseline measurement at 7 weeks before the end of rehabilitation.

The personal characteristics of the participants for whom T=0 and T=1 data were available (n=993) are presented in Table 1. The values of the two sport and two physical activity outcomes are given in Table 2. At T=0 and T=1 imputation for the PASIPD was applied to 33 and 84 subjects, respectively. For all other variables the percentage missing data was between zero and five percent. Table 3 shows the results of the intention to treat and on treatment multilevel analyses for all four

outcomes. All analyses were corrected for baseline value of the outcome, time between baseline and end of rehabilitation, duration of treatment, age, diagnosis, rehabilitation form and education. Analyses for both sport outcomes were also corrected for the value of the outcome in the year before rehabilitation. All other checked variables were not identified as confounders and no effect modification was found. The R&S program showed no significant improvements. Intention to treat analyses in the R&S + AaR group showed significant improvements in one sport (p=0.02) and one physical activity outcome (p=0.03). The on treatment analyses in the R&S + AaR group showed significant improvements in both sport outcomes (p<0.01 and p=0.02) and one physical activity outcome (p<0.01). An odds ratio of 1.72 means that the odds to participate in sport at T=1 is 1.72 higher in the intention to treat R&S + AaR group than in the control group. A regression coefficient of 7.31 means that subjects in the on treatment R&S + AaR group improved 7.31 points on the PASIPD score at T=1 compared to the subjects in the control group.

Table 2: Outcome variables in the year before rehabilitation, at baseline (T=0) and nine weeks after rehabilitation (T=1).

Outcome variable at different times	**Control (n=549)**	**R&S (n=233)**	**R&S + AaR (n=211)**
Year before rehabilitation			
Sport participation, *n (%)*	325 (60)	143 (62)	128 (61)
Mean sport score ± SD, $KJ \cdot kg^{-1} \cdot day^{-1}$	10.6 ± 15.9	10.1 ± 14.9	9.9 ± 13.5
Baseline (T=0)			
Sport participation, *n (%)*	222 (41)	130 (57)	121 (59)
Mean sport score ± SD, $KJ \cdot kg^{-1} \cdot day^{-1}$	3.7 ± 7.3	4.1 ± 5.6	5.5 ± 7.7
Meeting PA recommendation, *n (%)*	263 (48)	129 (57)	127 (60)
Mean PASIPD ± SD, $KJ \cdot kg^{-1} \cdot day^{-1}$	67.4 ± 55.5	59.9 ± 49.8	61.5 ± 45.8
Nine weeks after rehabilitation (T=1)			
Sport participation, *n (%)*	282 (52)	133 (58)	134 (65)
Mean sport score ± SD, $KJ \cdot kg^{-1} \cdot day^{-1}$	6.2 ± 10.3	5.9 ± 8.5	7.3 ± 9.4
Meeting PA recommendation, *n (%)*	294 (54)	119 (52)	132 (64)
Mean PASIPD ± SD, $KJ \cdot kg^{-1} \cdot day^{-1}$	67.2 ± 57.9	61.9 ± 49.6	67.3 ± 57.7

R&S, rehabilitation and sport intervention; AaR, active after rehabilitation intervention; SD, standard deviation; PA, physical activity; PASIPD, physical activity scale for individuals with physical disabilities.

Table 3: Multilevel analysis comparing both intervention groups with the control group on physical activity and sport outcomes.

Outcome	n	R&S			R&S + AaR		
Sport participation[a,b]		**Odds ratio (95% CI)**		**p**	**Odds ratio (95% CI)**		**p**
Intention to treat	932	1.36	(0.88 – 2.10)	0.16	1.72	(1.09 – 2.73)	0.02
On treatment	777	1.59	(0.94 – 2.69)	0.08	2.41	(1.36 – 4.26)	<0.01
PA recommendation[a]							
Intention to treat	934	0.96	(0.67 – 1.39)	0.85	1.54	(1.04 – 2.28)	0.03
On treatment	779	0.89	(0.58 – 1.37)	0.60	2.16	(1.33 – 3.52)	<0.01
Sport score[a,b]		**Regr. coeff.**	**(95% CI)**	**p**	**Regr. coeff.**	**(95% CI)**	**p**
Intention to treat	859	0.62	(-0.88 – 2.12)	0.42	1.16	(-0.44 – 2.77)	0.16
On treatment	718	-0.08	(-1.81 – 1.66)	0.93	2.36	(0.44 – 4.28)	0.02
PASIPD[a]							
Intention to treat	932	-0.34	(-8.70 – 8.02)	0.94	4.74	(-3.94 – 13.42)	0.28
On treatment	776	-4.29	(-13.97 – 5.40)	0.38	7.31	(-2.76 – 17.39)	0.16

R&S, rehabilitation and sport intervention; AaR, active after rehabilitation intervention; CI, confidence interval; PA, physical activity; Regr. coeff., regression coefficient; PASIPD, physical activity scale for individuals with physical disabilities.

[a]Data corrected for baseline value, time between baseline and end of rehabilitation, duration of treatment, age, diagnosis, rehabilitation form and education.

[b]Data corrected for outcome value in the year before rehabilitation.

Discussion

The main findings of this study were that the R&S program did not have a significant effect on any of the four outcomes, while the combination of the R&S and AaR programs improved both sport participation outcomes and one physical activity outcome, compared to the control group. All four outcomes show larger effects in the on treatment analyses than in the intention to treat analyses. Comparing the reported regression coefficients of the sport score and PASIPD to the absolute scores of these outcomes, showed that the improvements in the R&S + AaR group compared to the control group were clinically relevant. The interpretation of the clinical relevance of the odds ratios of sport participation and the physical activity recommendation is difficult, since both outcomes had a high prevalence, and therefore, the odds ratios cannot be interpreted as relative risks.[21] The relative risks of these outcomes are

lower than the reported odds ratios, but cannot be estimated since no statistical multilevel technique exists to estimate relative risks.

Mechanisms & Explanations

There are four potential explanations for our findings. First, the R&S intervention only focused on sport, which probably has a higher participation threshold for ex-rehabilitation patients than trying to improve every day physical activities.

Second, the R&S intervention consisted of only two counselling sessions and most subjects received only the first session. However, counselling especially after rehabilitation seems to be important. During the first months after rehabilitation, subjects have to resume their everyday lives, usually without the structure provided by the rehabilitation centre or the help of health care professionals. Counselling during this period is likely to provide the necessary stimulus and help to start or maintain sport and daily physical activities. The one short, not very interactive, R&S counselling session after rehabilitation appeared insufficient to accomplish this, especially since not many subjects received it. One strength of the AaR program was that people received more extensive counselling sessions after rehabilitation.

Third, a strength of both interventions was the use of personalized tailored counselling, which is applicable to a wide range of different individuals like this heterogeneous study population, which had different diagnoses, age, severity of disability and stage of physical activity change. However, the flexibility within this personalized tailored counselling was higher for the AaR program than for the R&S program, especially in the session(s) after rehabilitation.

Fourth, at the T=1 measurement all subjects were asked whether they received advice from a health care professional to participate in sport. In the control group 65% of the subjects received such advice, usually from a rehabilitation physician or a physical therapist. This was similar to the advice people received in the intervention group, besides their R&S sessions. Thus, usual care appears to be similar in the control and intervention centres when it comes to sport advice from health professionals. It could be that the R&S program did not add enough to this usual care to have an effect on sport and physical activity.

Literature Perspective

The findings of the present study are similar to the results of studies using individualized counselling in a different setting and in populations with different diagnoses. Randomised controlled trials showed that multiple session physical activity individualized counselling improved physical activity in both cardiac rehabilitation and type 2 diabetes patients.[22-24] In another randomised controlled trial in women with mobility limitations the group receiving a physical activity promotion program improved self-reported physical activity.[25] However, these data were derived from the weekly physical activity logs that were part of the intervention and comparable data were not available for the control group.

The present and discussed studies suggest that promoting physical activity in populations of people with a chronic disease or physical disabilities by using individualized tailored counselling in multiple session interventions can be effective in improving physical activity behaviour.

Limitations

Lost to follow up was 26% in both intervention groups and only 9% in the control group. Figure 1 showed that the compliance with the interventions in both groups was around 55%. The lost to follow up in the intervention groups and low compliance were mostly due to logistic and personal problems, especially in one of the four intervention centres. Due to the low compliance, on treatment analyses were added to the intention to treat analyses to allow evaluation of the interventions properly.

Both the sport score and the PASIPD score were based on MET values derived from the general population. It is possible that MET values for the same activity differ between the general population and a population of rehabilitating patients, or even within subgroups of the present study population. Consequently, the absolute values of the sport score and the PASIPD might not be fully accurate and comparison to the general population might be a problem. However, this did not have an effect on our analyses, since we looked at differences between two time points.

The timing of the baseline measurement was one of the difficulties in this study. Because the duration of treatment differed so much between subjects, baseline measurement at the start of rehabilitation was not a good option. The chosen time of 7 weeks before the end of rehabilitation gave two problems. First, determining the

last day of rehabilitation approximately two months in advance was difficult and led to variations in the actual time between baseline and end of rehabilitation. In the analyses correction for this time difference appeared to be necessary. Second, at this baseline measurement some people already had been participating in some rehabilitation centre facilitated sport activities, which could have happened more frequently in the probably more sport orientated intervention centres. This would explain the higher baseline number of people participating in sport in the intervention groups compared to the control group, while the number of people who participated in sport in the year before rehabilitation was equal in all groups. Multilevel analyses with sport participation (or score) in the year before rehabilitation and without sport participation (or score) at baseline showed higher and more significant odds ratios in both intervention groups compared to the control group. Thus, correcting for baseline values may lead to an underestimation of the effect of both interventions on sport participation and sport score, because baseline values for both sport outcomes were already higher in the intervention groups.

Another limitation of this study was the impossibility to perform a randomised controlled trial. Due to the current quasi-experimental design, the intervention and control population differed in rehabilitation form, duration of treatment, the time between baseline measurement and end of rehabilitation, and to a lesser extend in diagnoses. Correction for these variables and some other variables was necessary and led to loss of statistical power.

Clinical and research implications & generalizability

Considering the aforementioned limitations, it appears that the combination of the R&S and AaR program was able to improve sport and daily physical activity on the short term in this population of rehabilitation patients. All other rehabilitation patients, who would meet the inclusion and exclusion criteria of this study, would probably benefit from the R&S + AaR intervention. For those who would not meet these criteria, the effects of these interventions are unclear, especially for people who were excluded because they were not interested in sport at all and the small group (5.7%) of precontemplators (physically inactive people, who do not intend to become active in the next 6 months). Both these groups are probably the most difficult people to get more physically active. However, because the interventions consisted of

personalized tailored counselling and the tested population was already heterogeneous, the results of this study can probably be generalized to a wider population of patients in rehabilitation, including for example people with other diagnoses.

Another important question concerns the extent to which the R&S and AaR programs were additional to each other. In other words, would the AaR program on its own have had the same effect as the combination of the two? Although this study was unable to answer this question, it seems wise to integrate both interventions since the combination of sport and daily physical activity leaves the subjects with a wider range of physical activity options. A way to accomplish this would be to integrate the first session of both programs into one longer session, and focus on both sport and daily physical activity during three telephone sessions. Future research has to determine the extent of the results of the current study in terms of generalizability to other populations, as well as the dose-response and the long-term effects of the interventions.

Conclusion

This study showed that the sport stimulation program R&S on its own had no significant effect on sport participation and daily physical activity behaviour nine weeks after in- or outpatient rehabilitation. However, the combination of the R&S program and the daily physical activity promotion program AaR improved sports participation and daily physical activity behaviour. In conclusion, it is possible to improve short term physical activity behaviour just after rehabilitation by using personalized tailored counselling in physical activity promotion programs, consisting of several sessions during and after rehabilitation.

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Chapter 6

Successfully improving physical activity behaviour after rehabilitation

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Abstract

Objectives. To determine the effects of the physical activity promotion programs 'Rehabilitation & Sports' (R&S) and 'Active after Rehabilitation' (AaR) on sport and daily physical activity, one year after in- or outpatient rehabilitation.

Methods. Subjects (n=1202) were recruited from ten Dutch Rehabilitation centres. Subjects in the four intervention rehabilitation centres were randomised into a group receiving R&S only (n=315) and a group receiving R&S and AaR (n=284). Subjects in the six control centres (n=603) received usual care. Two sport outcomes and two daily physical activity outcomes were assessed with questionnaires at seven weeks before and one year after the end of rehabilitation. Most frequent diagnoses were stroke, neurological disorders, and back disorders.

Results. The R&S program showed no significant effects. Multilevel intention to treat analyses in the R&S + AaR group showed (borderline) significant improvements in one sport (p=0.02) and both physical activity outcomes (p=0.01 and p=0.05). The on treatment analyses in the R&S + AaR group showed similar, but stronger effects.

Conclusions. The combination of the R&S and AaR program improved physical activity behaviour and sport participation one year after in- or outpatient rehabilitation. The R&S program alone did not have any effects.

Introduction

The health benefits of a physically active lifestyle are well known in the general population.[1-5] For people with a physical disability a physically active lifestyle could improve every day functioning, reduce disability and reduce the risk of secondary health problems.[6-11] However, people with a disability are in general less physically active than the general population.[12,13] Consequently, getting people with disabilities more physically active is probably even more important than it already is for the general population.

For two reasons rehabilitation is an excellent opportunity to start promoting a physically active lifestyle. First, for many people rehabilitation is the start of learning to live with a disability. It might thus be an effective strategy, to integrate physical activity into the new everyday routine following rehabilitation. Second, rehabilitation treatment is focused on restoration of mobility but above that often includes structured sport related physical activities, such as swimming and fitness exercises. Trying to integrate such activities into everyday life is probably a good strategy to be physically active after rehabilitation. One of the problems with converting rehabilitation physical activities into daily life is the lack of sufficient care, just after rehabilitation. Consequently, physical activity does not have a high priority after rehabilitation and people easily become sedentary. This is why two physical activity promotion programs were developed that targeted people with a disability just before and just after the end of rehabilitation. The first program is a personalized, tailored counselling sport stimulation program called 'Rehabilitation & Sports' (R&S). The second personalized tailored counselling program is 'Active after Rehabilitation' (AaR) and promotes daily physical activity in general. The combination of these two programs was shown to be effective in increasing sport participation and general physical activity behaviour in people with a disability nine weeks after rehabilitation.[14] The effectiveness of these programs on the longer term is probably even more important but still unknown. The objective of this study is to determine the effects of the R&S program and the effects of the R&S program combined with the AaR program, on sports participation and daily physical activity behaviour, one year after the end of in- or outpatient rehabilitation.

Methods

Study Subjects

All in- or outpatients over 18 years of age from ten Dutch rehabilitation centres were candidates for inclusion in the study if they had one of the following diagnosis: amputation, stroke, neurological disorders, orthopaedic disorders, spinal cord injury, rheumatic related disorders, back disorders or whiplash. Subjects were excluded if one of the following criteria were met: (A) insufficient cognitive abilities to participate; (B) medical contra-indications for participating; (C) terminal or very progressive disease; (D) insufficient understanding of the Dutch language; (E) no interest at all in sport participation. Potential participants were identified by health care professionals in the rehabilitation centres and included by the research assistant at the centre, who gave oral information and asked for written informed consent. In January 2001, the Medical Ethics Committee of Rehabilitation Centre Het Roessingh in Enschede (the Netherlands) approved the study.

Study Design

The study included four intervention rehabilitation centres, in which the R&S intervention program already existed, and six control rehabilitation centres. Subjects in the control centres received usual care. Subjects in the intervention centres were randomised into a group receiving R&S only, and a group receiving both the R&S and AaR intervention programs. Randomisation envelopes were made for each intervention centre separately by an independent supervising researcher. A research assistant performed the baseline measurements, and sent every subject to an intervention counsellor with a sealed randomisation envelope, where it was opened. Consequently, research assistants in direct contact with the subjects were blinded to which intervention group the subjects were allocated.

Interventions

The R&S program aimed at improving sport participation after rehabilitation. The program consisted of a 30 min personalized tailored counselling session with a sport counsellor six weeks before the end of rehabilitation and a ten minute telephone check up six weeks after rehabilitation. The first session identified sport history, wishes, possibilities, facilitators and barriers, and this session resulted in a tailored

sport advice. Additionally, information on available and appropriate sports locations near the subject's home was provided. Recommended sports were usually non-competitive and most commonly consisted of swimming activities, exercising at a fitness centre, or exercising in a diagnosis-specific group. The second session identified sporting status, satisfaction with the given advice and reasons for not participating in sports. If necessary, the sport counsellor gave additional sport advice.

The AaR program aimed at improving daily physical activity in general after rehabilitation and was based on the stages of change concept of the Transtheoretical model.[15] This concept divides subjects into the precontemplation, contemplation, preparation, action and maintenance stages of physical activity behaviour change.[15] Subjects received a 40 min personalized tailored counselling session from a physical activity counsellor six weeks before the end of rehabilitation and three 15-20 min counselling sessions by telephone at two, five and eight weeks after the end of rehabilitation. The sessions were supported by stage of physical activity change specific folder material, based on materials from Health Partners & Io Solutions, Ltd. (Minneapolis, US). The program focused on identifying physical activity possibilities, integrating facilitators, overcoming barriers and using strategies to become more physically active, such as goal setting and rewarding.

Data Collection and Outcome Assessment

Data collection took place from March 2001 until December 2004. Questionnaires were administered under the supervision of a research assistant at the rehabilitation centre seven weeks before the end of rehabilitation (baseline) and at home one year after rehabilitation (follow-up). Personal characteristics were assessed using questionnaires. Body mass index was calculated from self-reported body height and body weight. Duration of treatment and hours of sport related physical activities during treatment were obtained from a computerized registration system of each rehabilitation centre.

Two sport participation and two daily physical activity outcomes were assessed at baseline and at one year follow-up, using questionnaires. The two sport participation outcomes were whether or not subjects participated in sport at that moment (yes/no) and a total sport score, which incorporated intensity and average duration of participation per week for each sport.[14] For both sport participation outcomes recall of

sport participation during the average week in the year before rehabilitation was recorded at baseline. The first daily physical activity outcome was whether or not the participants met the public health recommendation of being moderately physically active at least five days a week for 30 minutes per day, either continuously or intermittently with bouts of at least 5 minutes.[3,14] The second outcome was the 7-day recall Physical Activity Scale for Individuals with Physical Disabilities (PASIPD) which identifies leisure time, household and work-related physical activities.[16,17] If only one of the twelve items of the PASIPD was missing for a subject, imputation was performed using the most conservative value (least physically active option) of the missing item to calculate a total physical activity score (baseline: n=30; one year follow-up: n=42).

Statistical Analyses

Data analysis was performed in January and February 2005 according to a pre-established analysis plan. For all sport and physical activity outcomes measured at one year follow-up a multilevel analysis comparing both intervention groups to the control group was conducted.[18,19] Multilevel analyses were performed with the MLwiN (version 1.1, Institute of Education, London, UK, 2001) statistical computer program. To correct for differences at baseline between the groups, in all analyses a correction was used for the value of the particular outcome variable at baseline.

In all analyses, possible confounding effects of age, gender, baseline body mass index, marital status, having children living at home, education, monthly income, time between baseline and end of rehabilitation, time between end of rehabilitation and one year follow-up, time since start of complaints, duration of treatment, treatment form (in-, outpatient, or both), hours of sport related physical activities during treatment, diagnosis, medical complications at one year follow-up, sport participation and sport score in the year before rehabilitation, and the season of measurement was evaluated. Variables that changed the intervention regression coefficients by at least ten percent were identified as confounders and were corrected for in the final analysis. Interaction terms between age or gender and the two intervention variables were also added to investigate possible effect modification ($p<0.05$).

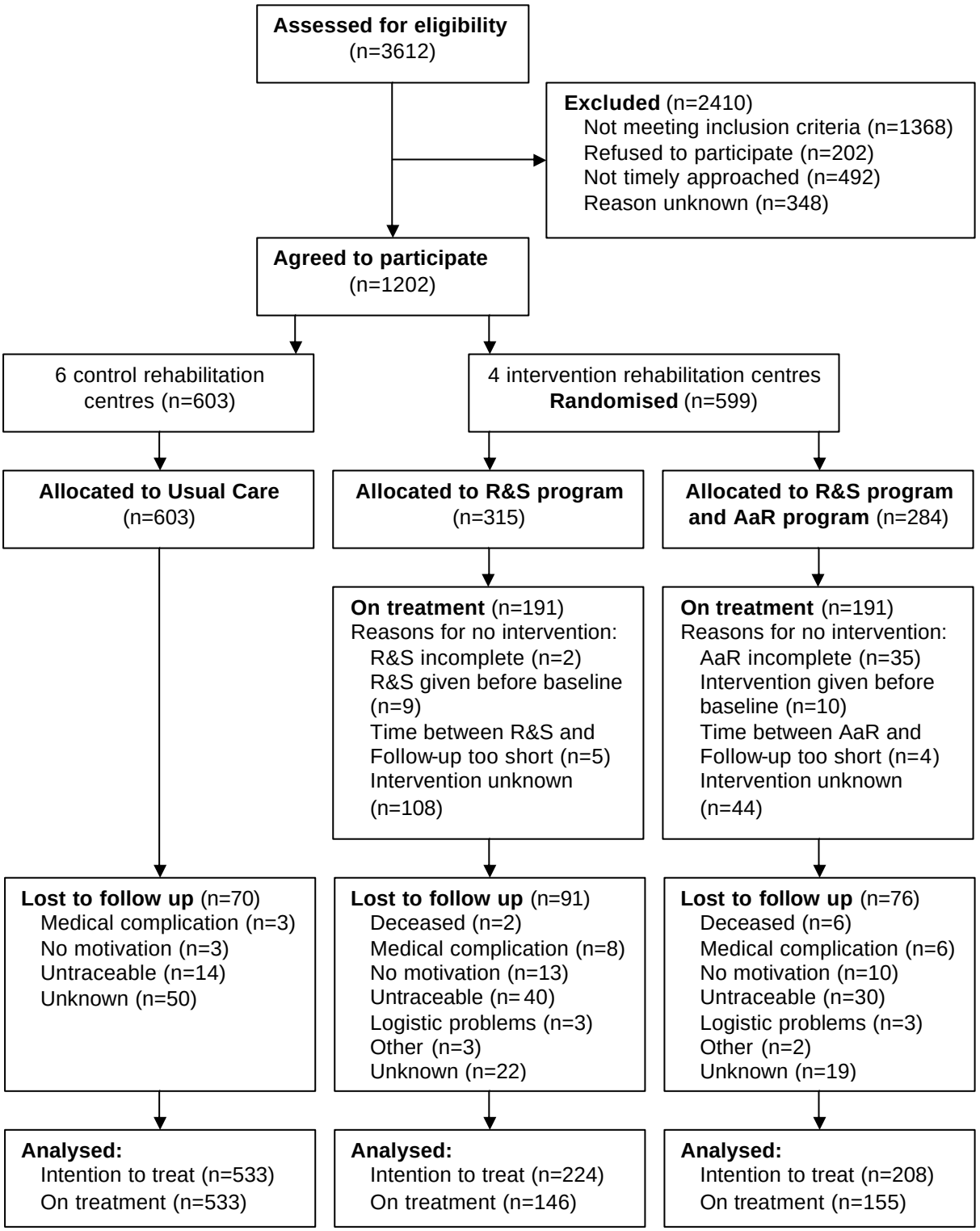

Figure 1: Flow of participants through the study.

Besides intention to treat analyses, on treatment analyses were performed, in which only the people who actually received their intervention were compared to the control group. The R&S on treatment group and the R&S + AaR on treatment group contained all subjects who received at least the first respectively first two sessions between baseline and one year follow-up. For both on treatment intervention groups the time between the last session and one year follow-up had to be longer than 120 days (because only long term effects were studied). In all analyses p-values < 0.05 were considered statistically significant.

Results

Figure 1 shows the flow of participants through the study. In one intervention centre, the last 18 subjects were not randomised, but had to be allocated to the R&S group, because there was no AaR counsellor available anymore in that centre. This accounts for the lower number of subjects in the R&S + AaR group (n=284) compared to the R&S group (n=315).

Compliance with the different sessions of the interventions was as follows. Ninety-four subjects in the analysed R&S on treatment group (64%) received the check up telephone call. Of the analysed subjects in the R&S + AaR on treatment group 122 (79%) received the first R&S session. Furthermore, of the analysed subjects in the R&S + AaR on treatment group 141 (91%) subjects received all four AaR sessions, of the remaining subjects 4 (3%), and 10 (6%) received two and three AaR sessions, respectively.

The personal characteristics of the subjects (n=965) are presented in Table 1. Table one shows that there were some differences between the groups in treatment form, duration of treatment, total time of sport related activities during treatment, time between baseline and end of rehabilitation, education, and diagnosis. Table 2 shows the values of the two sport and the two physical activity outcomes in the year before rehabilitation, at baseline, and one year after rehabilitation. The results of the intention to treat and on treatment multilevel analyses for all four outcomes are presented in table 3. All analyses needed correction for baseline value of the outcome, time between baseline and end of rehabilitation, hours of sport related physical activities during treatment, diagnosis, rehabilitation form and education. The R&S intervention did not result in significant improvements. Intention to treat

Table 1: Personal characteristics of the subjects in all three groups.

Characteristic	**Control (n=533)**	**R&S (n=224)**	**R&S + AaR (n=208)**
Gender male, *n (%)*	270 (51)	120 (54)	107 (51)
Mean age ± SD, *y*	46 ± 14	46 ± 14	47 ± 12
Mean body mass index ± SD, $kg \cdot m^{-2}$	25.9 ± 5.0	25.2 ± 4.4	25.1 ± 4.1
Treatment form, *n (%)*			
Inpatient	14 (3)	54 (25)	44 (21)
Outpatient, first inpatient	130 (24)	71 (32)	53 (26)
Outpatient	385 (73)	95 (43)	108 (53)
Mean duration of treatment ± SD, *h*	89 ± 129	167 ± 167	172 ± 207
Mean total time of sport related activities during treatment ± SD, *h*	19 ± 24	40 ± 58	44 ± 71
Mean time between baseline and end of rehabilitation ± SD, *days*	72 ± 71	102 ± 116	116 ± 124
Education, *n (%)*			
Primary school	57 (10)	11 (5)	16 (8)
Secondary school low	217 (41)	99 (44)	69 (33)
Secondary school high / College low	153 (29)	68 (30)	75 (36)
College high / University	106 (20)	46 (21)	47 (23)
Diagnosis group, *n (%)*			
Amputation	23 (4)	19 (8)	18 (9)
Stroke	154 (29)	56 (25)	45 (22)
Neurological disorders	93 (18)	34 (15)	23 (11)
Orthopaedic disorders	54 (10)	15 (7)	19 (9)
Spinal cord injury	18 (3)	22 (10)	17 (8)
Rheumatic related disorders	41 (8)	18 (8)	28 (14)
Back disorders	88 (17)	26 (12)	19 (9)
Chronic pain / whiplash	58 (11)	33 (15)	37 (18)

R&S, rehabilitation and sport intervention; AaR, active after rehabilitation intervention; SD, standard deviation.

analyses in the R&S + AaR group showed significant improvements in one sport (p=0.02), one physical activity outcome (p=0.01) and a marginally significant improvement in the other physical activity outcome (p=0.05). The on treatment analyses in the R&S + AaR group showed stronger improvements in the same sport

(p=0.01) and physical activity outcome (p<0.01), and a marginally significant improvement in the other physical activity outcome (p=0.05). Significant interactions between age and the R&S + AaR intervention revealed that the intervention was more effective in improving sport participation and both physical activity outcomes for older adults than for younger adults.

Table 2: Outcome variables in the year before rehabilitation, at baseline and one year after rehabilitation.

Outcome variable at different times	Control (n=533)	R&S (n=224)	R&S + AaR (n=208)
Year before rehabilitation			
Sport participation, *n (%)*	315 (60)	132 (59)	126 (61)
Mean sport score ± SD, $KJ \cdot kg^{-1} \cdot day^{-1}$	10.2 ± 15.0	9.5 ± 14.4	10.0 ± 13.3
Baseline			
Sport participation, *n (%)*	214 (41)	122 (55)	117 (58)
Mean sport score ± SD, $KJ \cdot kg^{-1} \cdot day^{-1}$	3.6 ± 6.9	4.2 ± 6.1	5.0 ± 7.3
Meeting PA recommendation, *n (%)*	257 (49)	123 (56)	127 (61)
Mean PASIPD ± SD, $KJ \cdot kg^{-1} \cdot day^{-1}$	68.2 ± 57.9	60.2 ± 50.8	65.4 ± 51.6
One year after rehabilitation			
Sport participation, *n (%)*	280 (53)	125 (56)	141 (68)
Mean sport score ± SD, $KJ \cdot kg^{-1} \cdot day^{-1}$	6.3 ± 10.5	5.9 ± 9.1	7.8 ± 10.6
Meeting PA recommendation, *n (%)*	290 (55)	130 (59)	135 (67)
Mean PASIPD ± SD, $KJ \cdot kg^{-1} \cdot day^{-1}$	63.7 ± 53.1	63.9 ± 54.7	71.3 ± 64.2

R&S, rehabilitation and sport intervention; AaR, active after rehabilitation intervention; SD, standard deviation; PA, physical activity; PASIPD, physical activity scale for individuals with physical disabilities.

Discussion

The results of the current study suggest that the combination of the R&S and AaR program was able to improve physical activity behaviour and sport participation one year after the end of rehabilitation. The R&S program alone did not have an effect on any of the outcomes. These long term findings are quite similar to the results of this trial nine weeks after rehabilitation that showed no effect of the R&S program alone, but significant improvements in both sport and one daily physical activity outcome in the R&S + AaR group.[14] A difference with the results at nine weeks was the

significant interaction between age and the R&S + AaR intervention. On the longer term it seems that R&S + AaR was more effective in older people.

Table 3: Multilevel analysis comparing both intervention groups with the control group on physical activity and sport outcomes.

Outcome	n	R&S			R&S + AaR		
Sport participation[a]		**Odds ratio (95% CI)**		**p**	**Odds ratio (95% CI)**		**p**
Intention to treat	901	0.99	(0.67 – 1.47)	0.98	1.66	(1.09 – 2.51)	0.02
On treatment	785	1.08	(0.68 – 1.72)	0.75	1.98	(1.22 – 3.20)	0.01
PA recommendation[a]							
Intention to treat	898	1.30	(0.90 – 1.88)	0.16	1.68	(1.13 – 2.48)	0.01
On treatment	784	1.31	(0.86 – 2.00)	0.22	1.96	(1.26 – 3.04)	<0.01
Sport score[a]		**Regr. coeff.**	**(95% CI)**	**p**	**Regr. coeff.**	**(95% CI)**	**p**
Intention to treat	873	-0.60	(-2.26 – 1.05)	0.48	0.65	(-1.08 – 2.38)	0.46
On treatment	758	-0.77	(-2.68 – 1.14)	0.43	1.41	(-0.53 – 3.34)	0.15
PASIPD[a]							
Intention to treat	876	4.06	(-6.43 – 14.55)	0.45	10.78	(-0.06 – 21.62)	0.05
On treatment	761	2.69	(-8.78 – 14.15)	0.65	11.36	(-0.07 – 22.79)	0.05

R&S, rehabilitation and sport intervention; AaR, active after rehabilitation intervention; CI, confidence interval; PA, physical activity; Regr. coeff., regression coefficient; PASIPD, physical activity scale for individuals with physical disabilities.

[a]Data corrected for baseline value, time between baseline and end of rehabilitation, hours of sport participation during treatment, diagnosis, rehabilitation form and education.

When comparing the results in the R&S + AaR group nine weeks and a year after rehabilitation it seems that physical activity behaviour improved further during follow-up, whereas sport participation decreased a little over time. The lack of an effect on the sport score at one year could mean that people still reported that they participated in sport, but spent less time on sport than they did at nine weeks. However, people appear to spend more time on daily physical activities at one year, which probably has a lower participation threshold than sports and probably was easier to integrate into daily life. This could also be one of the reasons why the R&S program alone was not effective. Both programs consisted of personalized tailored counselling, but the R&S program, especially its second session, was more

standardized than the AaR program and left less room for tailoring. The use of the stages of physical activity change concept in the AaR program probably also made AaR a better tailored program than R&S.

Besides the differences in content between both interventions the number, timing and duration of the counselling sessions was also different. People in the R&S + AaR group received more counselling. Especially the multiple AaR counselling sessions after the rehabilitation period may have been effective. During this period subjects had to resume their everyday lives without help from health professionals and without the structured sport related activities that were part of the rehabilitation program. Counselling during this period is likely to have provided the necessary stimulus and may have helped to start or maintain sport and daily physical activities.

A final explanation for the relative ineffectiveness of the R&S program could be the sport advice subjects reported to have received from health care professionals. In the control group 65% of the subjects stated to have received such advice, usually from a rehabilitation physician or a physical therapist. This was similar to what subjects in the intervention group received, besides their R&S sessions. Thus, usual care appears to be similar in the control and intervention centres when it comes to sport advice from health professionals. It could be that the R&S program alone did not add enough to this usual care to have an effect on sport and physical activity.

Literature Perspective

Some studies using individualized counselling in a different setting and in populations with different diagnoses have been reported in the literature. In a randomised controlled trial among 70 people with type 2 diabetes, the intervention group received an exercise counselling program and improved physical activity level 6 months after baseline and maintained this level after 12 months.[20] The exercise counselling program consisted of two stage of change tailored 30-min exercise counselling sessions at baseline and 6 months after baseline, and four follow-up support phone calls at 1, 3, 7 and 9 months after baseline. A similar randomised controlled trial, among 340 people with type 2 diabetes, also used an individual behavioural counselling intervention that increased self-reported voluntary physical activity.[21] This two year physician based program consisted of an initial counselling session, which was followed 1 month later and than every 3 months by a telephone session. Another

randomised controlled trial showed that one exercise consultation during phase IV cardiac rehabilitation improved self-reported leisure physical activity among 31 subjects, four weeks after the intervention.[22]

The present and discussed studies seem to suggest that physical activity promotion interventions using individualized tailored counselling in populations of people with a chronic disease or with physical disabilities can be effective in improving physical activity behaviour. The stages of physical activity change concept can be helpful in such interventions. However, besides the results from the current study not much is known about the effectiveness of such interventions more than three months after the last intervention session.

Limitations

Lost to follow up was 29% in the R&S group, 27% in the R&S +AaR group and 12% in the control group (figure 1). Compliance with the interventions was 61% in the R&S and 67% in the R&S +AaR group. Since compliance was not high, on treatment analyses were added to the intention to treat analyses to allow better evaluation of the interventions. Logistic and personnel problems, especially in one of the four intervention centres, had a negative effect on compliance and lost to follow up and led to the relatively high number of people in the unknown categories in the intervention groups.

The timing of the baseline measurement was one of the difficulties in this study. Performing the baseline measurement at the start of rehabilitation was not an option, because duration of treatment differed so much between subjects. However, the chosen time of 7 weeks before the end of rehabilitation gave two problems. First, determining the last day of rehabilitation approximately two months in advance was difficult and led to variations in the actual time between baseline and end of rehabilitation. Consequently, all analyses had to be corrected for the time between baseline and end of rehabilitation. Second, at baseline some people already had been participating in some rehabilitation centre facilitated sport activities. The higher baseline values for sport participation and sport score in the intervention groups compared to the control group suggest this might have happened more frequently in the intervention centres. Especially, since the number of people who participated in sport in the year before rehabilitation was equal in all groups. This could have led to

an underestimation of the effect of the interventions on sport participation and sport score.

For practical and ethical reasons the study was a quasi experimental instead of a randomised controlled trial. Consequently, the intervention and control populations differed in rehabilitation form, duration of treatment, total time of sport related activities during treatment, the time between baseline measurement and end of rehabilitation, and to a lesser extend in diagnoses and education. Correction for these variables in all analyses was necessary, except for duration of treatment, which was probably sufficiently incorporated in the other correcting variables.

Clinical and research implications & generalizability

The use of personalized tailored counselling made the interventions applicable to a wide range of different individuals in this heterogeneous study population, which included differences in diagnoses, age, severity of disability, and stage of physical activity change. However, the effectiveness of the R&S + AaR intervention probably differs between subgroups. For example the results showed that the R&S + AaR intervention was more effective in older people. However, it was not possible to determine for which age groups the intervention was effective and for which it was not. Besides possible differences in effectiveness, the R&S + AaR intervention can probably be generalized to all other rehabilitation patients, who would meet the inclusion and exclusion criteria of this study. The effects of the R&S + AaR intervention on people who would not meet these criteria remains unclear. On the one hand, given the heterogeneous population of the current study and the use of personalized tailored counselling, the R&S + AaR intervention might be beneficial for a wider population of patients in rehabilitation, including for example people with other diagnoses. On the other hand, the effectiveness of the R&S + AaR intervention is doubtful for people who have no intention at all to become more physically active.

Another unanswered question is whether the R&S and AaR programs were additional to each other or if the AaR program on its own would have had the same effect? From a theoretical point of view it seems wise to integrate both interventions. The combination of sport and daily physical activity leaves the subjects with a wider range of physical activity options. To accomplish this, the first session of both programs could be integrated into one longer session, and the focus during three

telephone sessions could be on both sport and daily physical activity. In conclusion, future research has to determine the effectiveness of the R&S + AaR intervention in different (sub)populations, as well as the dose-response relationship.

Conclusions

The results of the current study suggest that the combination of the R&S and AaR program was able to improve physical activity behaviour and sport participation one year after in- or outpatient rehabilitation. The R&S program alone did not have any significant effects. These results were quite similar to those reported at nine weeks after rehabilitation.[14] In conclusion, it is possible to obtain a long lasting improvement in physical activity behaviour by using physical activity promotion programs, consisting of several personalized tailored counselling sessions during and after rehabilitation.

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Chapter 7

Underlying mechanisms of improving physical activity behaviour after rehabilitation

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Abstract

Objectives. To study the underlying mechanisms of the combined sport stimulation program 'Rehabilitation & Sports' (R&S) and daily physical activity promotion program 'Active after Rehabilitation' (AaR), by identifying mediators through which these interventions improved physical activity behaviour.

Methods. Subjects in four intervention rehabilitation centres received R&S and AaR (n=284). Subjects in six control centres (n=603) received usual care. Physical activity behaviour and determinants of physical activity were assessed with questionnaires at seven weeks before, at nine weeks and one year after the end of rehabilitation. To analyse the mediating effect of each determinant, the percentage decrease in the intervention regression coefficient caused by adding each determinant to a basic model was assessed. This basic model was used in an earlier study that assessed the effects of the combination of the R&S + AaR intervention on physical activity behaviour.

Results. Determinants that were mediators of the intervention induced improvement in physical activity behaviour were: attitude, the perceived benefits improved health and reduced risk of disease, better feeling about oneself and improved fitness, and the barrier limited environmental possibilities. The percentage change in the intervention coefficient caused by these mediators ranged from –35.3% to –16.3% and from –28.4% to –11.3% at nine weeks and one year after rehabilitation, respectively. Self-efficacy, social influence from family and from friends, the perceived benefit improved daily functioning, and the barriers health conditions and lack of energy were also identified as mediators, but for only one of the follow up measurements.

Conclusions. The current study gave some insights into the underlying mechanisms of the effective combination of the R&S and AaR interventions. Almost all psychosocial determinants as well as several barriers to physical activity were identified as mediators of the intervention induced improvements in physical activity behaviour.

Introduction

For the general population, it is well documented that a physically active lifestyle is beneficial for a person's health.[1-5] Such a lifestyle could improve every day functioning, reduce disability and reduce the risk of secondary health problems in people with a physical disability.[6-11] However, a sedentary lifestyle is more common among people with a disability than among the general population.[12,13] Consequently, getting people with disabilities more physically active is probably even more important than it already is for the general population.

In a recent large multi-centre intervention study (n=1202) the effectiveness of two physical activity promotion programs for people with a physical disability during and after their in- or outpatient rehabilitation was assessed. The first program was a personalized, tailored counselling sport stimulation program called 'Rehabilitation & Sports' (R&S). The second personalized tailored counselling program was called 'Active after Rehabilitation' (AaR) and promoted physical activity behaviour in general. The results of this intervention study showed that the combination of the R&S and AaR program successfully improved physical activity behaviour nine weeks and one year after rehabilitation.[14,15]

The current study takes a closer look at the underlying mechanisms of this effective combination of interventions by identifying mediating variables. In an earlier paper we described the conceptual 'Physical Activity for people with a Disability model', that was based on the literature.[16] This model conceptualises the possible relationship between physical activity, its determinants, and functioning in people with a disability. The earlier reported improvement in physical activity behaviour is believed to have been caused by improvements in determinants of physical activity, induced by the combined R&S and AaR interventions. These determinants are thought to have been mediators, through which the combined interventions improved physical activity behaviour. Accounting to the conceptual model, possible mediators include attitude, self-efficacy, social influence, barriers, and perceived benefits. However, which variables were the actual mediators of the intervention effects on physical activity behaviour has yet to be shown. Knowledge about mediators in physical activity promotion interventions can be helpful in the design of new interventions, as well as in the improvement of existing interventions, such as R&S + AaR. Consequently, the objective of this study is to study the underlying mechanisms of the combined R&S +

AaR intervention, by identifying mediators through which the intervention improved physical activity behaviour, at nine weeks and one year after rehabilitation.

Methods

Study Subjects

All in- or outpatients over 18 years of age from ten Dutch rehabilitation centres were candidates for inclusion in the study if they had one of the following diagnoses: amputation, stroke, neurological disorders, orthopaedic disorders, spinal cord injury, rheumatic related disorders, back disorders or whiplash. Subjects were excluded if one of the following criteria were met: (A) insufficient cognitive abilities to participate; (B) medical contra-indications for participating; (C) terminal or very progressive disease; (D) insufficient understanding of the Dutch language; (E) no interest at all in sport participation. A research assistant obtained written informed consent from 1202 subjects. In January 2001, the Medical Ethics Committee of Rehabilitation Centre Het Roessingh in Enschede (the Netherlands) approved the study.

Study Design

Subjects in the six control rehabilitation centres received usual care. Subjects in the four intervention centres were randomly assigned to the R&S program only, or to both the R&S and AaR intervention programs. However, since the R&S intervention alone was shown to be ineffective,[14,15] the current analysis contains only data from the subjects that have received both the R&S and AaR intervention programs, and from the control group.

Interventions

The R&S program aimed at improving sport participation after rehabilitation. The program consisted of a 30-min personalized tailored counselling session with a sport counsellor six weeks before the end of rehabilitation and a 10-min telephone check up six weeks after rehabilitation. Recommended sports were usually non-competitive and most commonly consisted of swimming activities, exercising at a fitness centre or exercising in a diagnosis-specific group.

The AaR program aimed at improving physical activity behaviour in general after rehabilitation and was based on the stages of change concept of the Transtheoretical

model.[17] Subjects received a 40-min personalized tailored counselling session from a physical activity counsellor six weeks before the end of rehabilitation and three 20-min counselling sessions by telephone at two, five and eight weeks after the end of rehabilitation. The sessions were supported by stage of physical activity change specific folder material. The program focused on identifying physical activity possibilities, integrating facilitators, overcoming barriers and using strategies to become more physically active, such as goal setting and rewarding. Both interventions are described in more detail elsewhere.[14]

Data Collection and Outcome Assessment

Data collection took place from March 2001 until December 2004. Questionnaires were administered under the supervision of a research assistant at the rehabilitation centre seven weeks before the end of rehabilitation (T=0), and at home nine weeks (T=1) and one year after rehabilitation (T=2). At baseline, personal characteristics were assessed using questionnaires. Body mass index was calculated from self-reported body height and body weight. Duration of treatment and hours of sport related physical activities during treatment were obtained from the computerized registration system of each rehabilitation centre at T=1.

At all three measurements, physical activity behaviour was assessed with the 7-day recall Physical Activity Scale for Individuals with Physical Disabilities (PASIPD), which identifies leisure time, household and work-related physical activities.[18,19] If only one of the twelve items of the PASIPD was missing for a subject, imputation was performed using the most conservative value (least physically active option) of the missing item to calculate a total physical activity score (T=0, T=1 and T=2 had 22, 59, 35 imputations, respectively).

The following determinants of physical activity were measured at T=0, T=1 and T=2 using questionnaires: attitude towards physical activity behaviour, self-efficacy towards physical activity behaviour,[21] and social influence from family and friends concerning physical activity behaviour.[20] In addition, seven important barriers to physical activity and six perceived benefits were selected from a questionnaire of Sallis et al.[22] These barriers were: lack of money, lack of time, lack of energy, lack of motivation, limited possibilities in the person's environment, transportation problems, and the person's health conditions. The perceived benefits of regular physical activity

were: improved health and reduced risk of disease, better feeling about oneself, improved fitness, improved daily functioning, weight loss, and meeting new people. All determinants were scored on a 1-5 Likert-type scale, except self-efficacy (0-10 scale).

Statistical Analyses

Data analysis was performed in March and April 2005 according to a pre-established analysis plan. The T=1 and T=2 data were analysed separately using multilevel analysis,[23,24] which were performed with the MLwiN statistical computer program (version 1.1, Institute of Education, London, UK, 2001). One by one a single determinant of physical activity was added to the basic model that was used in the earlier analysis that assessed the effect of the combination of both interventions on the PASIPD score.[14,15]

The basic model contained corrections for the rehabilitation centre level, for differences between groups at T=0 in the outcome variable, and for confounders identified during previous analyses.[14,15] These confounders were used for all analyses: time between baseline and end of rehabilitation, diagnosis, rehabilitation form and level of education. The T=1 analysis was also corrected for duration of treatment and age, while the T=2 analysis was corrected for hours of sport related physical activities during treatment. In order to look at intervention induced changes in each determinant, the basic model was also corrected for the baseline value of that determinant.

The percentage change in the intervention regression coefficient that was caused by adding a determinant to the basic model was recorded for each determinant of physical activity. By correcting the basic model for each determinant separately, the role of this determinant in the underlying mechanism of the interventions could be assessed. Determinants that reduced the intervention regression coefficient by at least ten percent were considered as mediators of the R&S + AaR intervention induced improvement in physical activity behaviour. In order to assess the direction of the relationship between each determinant and the PASIPD score, the regression coefficients of the determinant were studied. After adding all determinants separately to the basic model, the six strongest mediators were added together to the basic model.

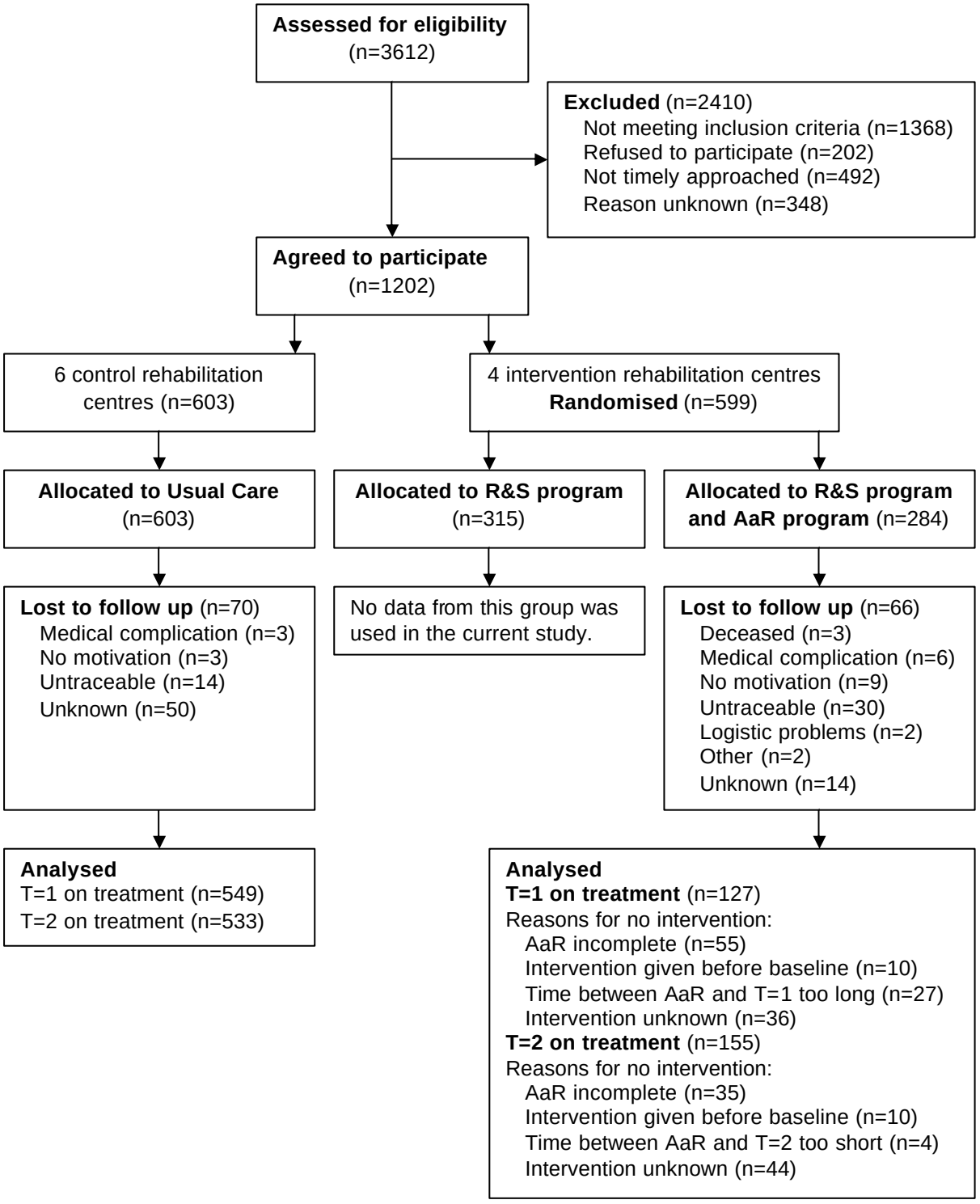

Figure 1: Flow of participants through the study.

Only subjects in the intervention group who actually received the interventions (i.e. 'on treatment') were analysed. On treatment was defined as all subjects who had received at least the first two AaR sessions between baseline and the particular measurement. Furthermore, the time between the last intervention session and one year follow up had to be shorter and longer than 120 days for the T=1 and T=2 on treatment definitions, respectively.

Results

The flow of participants through the study is presented in Figure 1, including lost to follow up and on treatment data. Table 1 shows the baseline personal characteristics of all analysed subjects (n=731). The characteristics show some differences between the intervention and control group in treatment form, duration of treatment, total time of sport related activities during treatment, time between baseline and end of rehabilitation, education, and diagnosis. The T=1 or T=2 basic models were corrected for these variables. The absolute values of the determinants in the intervention and control group at all three measurements are presented in Table 2. It must be noted that these values are not corrected for any of the observed baseline differences in personal characteristics between the intervention and control group.

Table 3 shows at T=1 and at T=2 the percentage of change in the intervention regression coefficient caused by adding each determinant separately to the basic model. For example, the results mean that the effect at T=1 of the R&S + AaR intervention on the PASIPD score was reduced by 14.8% due to the difference in self-efficacy scores between the intervention and control group at T=1. This means that self-efficacy was a mediator of the intervention induced improvement in physical activity behaviour at T=1. Table 3 shows that attitude, the barrier health conditions, and the perceived benefits improved health and reduced risk of disease, better feeling about oneself, improved fitness and improved daily functioning were the strongest mediators at T=1. All six mediators were added together to the basic model, which resulted in a reduction of the intervention effect of 102.6% at T=1. For the T=2 analysis, the six strongest mediators attitude, social influence from family, the barrier limited environmental possibilities, and the perceived benefits improved health and reduced risk of disease, better feeling about oneself, as well as improved

fitness were added to the basic model, resulting in a reduction of 59.0% in the intervention effect.

Table 1: Personal characteristics of the subjects in both groups.

Characteristic	**Control (n=566)**	**R&S + AaR (n=165)**
Gender male, *n (%)*	290 (51)	79 (48)
Mean age ± SD, *y*	46 ± 14	46 ± 13
Mean body mass index ± SD, $kg*m^{-2}$	25.8 ± 5.0	25.4 ± 4.2
Treatment form, *n (%)*		
Inpatient	15 (3)	34 (21)
Outpatient, first inpatient	139 (25)	44 (27)
Outpatient	408 (72)	85 (52)
Mean duration of treatment ± SD, *h*	90 ± 128	164 ± 185
Mean total time of sport related activities during treatment ± SD, *h*	19 ± 24	42 ± 69
Mean time between baseline and end of rehabilitation ± SD, *days*	71 ± 71	111 ± 117
Education, *n (%)*		
Primary school	59 (11)	11 (7)
Secondary school low	234 (41)	53 (32)
Secondary school high / College low	160 (28)	65 (40)
College high / University	112 (20)	35 (21)
Diagnosis group, *n (%)*		
Amputation	28 (5)	16 (10)
Stroke	162 (29)	34 (21)
Neurological disorders	101 (18)	18 (11)
Orthopaedic disorders	60 (11)	12 (7)
Spinal cord injury	18 (3)	15 (9)
Rheumatic related disorders	42 (7)	23 (14)
Back disorders	90 (16)	16 (10)
Chronic pain / whiplash	60 (11)	30 (18)

R&S, rehabilitation and sport intervention; AaR, active after rehabilitation intervention; SD, standard deviation.

The direction of the relation between each determinant and physical activity behaviour was usually as had been expected. Higher scores for self-efficacy, attitude, social influence and perceived benefits were associated with higher PASIPD scores. Furthermore, subjects who experienced a certain barrier more frequently had on average lower PASIPD scores. However, people who more frequently experienced a lack of money at T=1 or a lack of time at T=2 as barriers also had higher PASIPD scores. For both barriers the direction of the relationship with the PASIPD score at the other measurement moment was unclear.

Table 2: Mean determinant score for the intervention and control group at T=0, T=1 and T=2.

Determinant	**Control**			**Intervention**		
	Mean ± SD			Mean ± SD		
	T=0	T=1	T=2	T=0	T=1	T=2
Self-efficacy	5.3 ± 1.9	5.0 ± 2.0	5.0 ± 2.1	5.4 ± 2.1	5.3 ± 2.1	5.3 ± 2.2
Attitude	4.3 ± 0.9	4.2 ± 0.9	4.1 ± 1.0	4.4 ± 0.8	4.4 ± 0.7	4.4 ± 0.8
Social influence family	4.3 ± 0.9	4.2 ± 1.0	4.1 ± 1.0	4.4 ± 0.8	4.4 ± 0.8	4.4 ± 0.9
Social influence friends	4.2 ± 0.9	4.1 ± 0.9	4.0 ± 1.1	4.4 ± 0.8	4.3 ± 0.8	4.2 ± 0.9
Perceived benefits						
Improved health, reduced risk of disease	3.8 ± 1.1	3.6 ± 1.1	3.5 ± 1.2	3.8 ± 1.1	3.9 ± 1.1	3.8 ± 1.1
Better feeling about oneself	4.1 ± 0.9	4.0 ± 0.9	3.8 ± 1.0	4.2 ± 0.9	4.2 ± 0.7	4.1 ± 0.9
Improved fitness	4.2 ± 0.9	4.0 ± 0.9	3.8 ± 1.0	4.2 ± 0.9	4.2 ± 0.7	4.1 ± 0.9
Improved daily functioning	3.9 ± 0.9	3.7 ± 1.0	3.6 ± 1.0	4.1 ± 0.8	4.0 ± 0.8	3.8 ± 1.0
Weight loss	3.3 ± 1.2	3.3 ± 1.1	3.3 ± 1.2	3.3 ± 1.2	3.4 ± 1.1	3.2 ± 1.2
Meeting new people	3.5 ± 1.1	3.5 ± 1.0	3.5 ± 1.0	3.8 ± 1.0	3.6 ± 1.0	3.6 ± 1.0
Barriers						
Health conditions	3.7 ± 1.1	3.5 ± 1.1	3.5 ± 1.2	3.7 ± 1.0	3.5 ± 1.1	3.5 ± 1.0
Limited environmental possibilities	2.5 ± 1.2	2.4 ± 1.2	2.5 ± 1.3	2.6 ± 1.2	2.3 ± 1.2	2.5 ± 1.2
Lack of time	2.2 ± 1.0	2.2 ± 1.0	2.2 ± 1.0	2.2 ± 1.0	2.2 ± 0.9	2.3 ± 0.9
Lack of motivation	2.2 ± 1.0	2.3 ± 1.0	2.4 ± 1.0	2.2 ± 1.0	2.2 ± 0.9	2.3 ± 0.9
Lack of money	1.7 ± 1.0	1.9 ± 1.1	2.0 ± 1.1	1.9 ± 1.1	2.0 ± 1.2	2.2 ± 1.2
Lack of energy	3.0 ± 1.2	3.0 ± 1.2	3.1 ± 1.2	3.1 ± 1.2	3.0 ± 1.1	3.1 ± 1.0
Transportation problems	2.0 ± 1.2	1.9 ± 1.2	1.8 ± 1.1	2.0 ± 1.3	2.0 ± 1.2	1.9 ± 1.2

T=0, measurement at seven weeks before the end of rehabilitation; T=1, measurement at nine weeks after rehabilitation; T=2 measurement at one year after rehabilitation; SD, standard deviation.

Table 3: Percentage change in the intervention regression coefficient by adding a determinant, at T=1 and T=2.

Determinant	T=1	T=2
	% change	% change
Self-efficacy	-14.8	-2.6
Attitude	-29.6	-11.3
Social influence family	-8.6	-11.3
Social influence friends	-5.8	-10.2
Perceived benefits of physical activity		
Improved health, reduced risk of disease	-35.3	-28.4
Better feeling about oneself	-18.0	-13.4
Improved fitness	-24.7	-14.3
Improved daily functioning	-26.1	-9.4
Weight loss	2.3	2.3
Meeting new people	-2.6	4.6
Barriers to physical activity		
Health conditions	-47.0	4.4
Limited environmental possibilities	-16.3	-26.0
Lack of time	-8.8	-7.3
Lack of motivation	-4.5	-1.8
Lack of money	29.6	7.5
Lack of energy	-13.5	12.1
Transportation problems	11.2	2.1

T=1, measurement at nine weeks after rehabilitation; T=2 measurement at one year after rehabilitation

Discussion

The results of this study showed that the earlier reported increase in physical activity behaviour[14,15] can partly be explained by differences in determinants of physical activity between the intervention and control group that were induced by the combination of the R&S and AaR interventions. Apparently, the working mechanism of the combined intervention included the changing of determinants of physical activity, which mediated the improvement in physical activity behaviour. Determinants that were identified as mediators of the interventions induced improvement in physical activity behaviour at both T=1 and T=2 were attitude, the perceived benefits improved health and reduced risk of disease, better feeling about oneself and improved fitness, and the barrier limited environmental possibilities. Self-efficacy,

social influence from family and from friends, the perceived benefit improved daily functioning, and the barriers health conditions and lack of energy were also identified as mediators, but either at only T=1 or T=2. Surprisingly, corrections of the basic model for the barriers lack of money, lack of energy, and transportation problems increased the intervention effect at one of the measurements, but not at the other.

The intervention effects on physical activity behaviour were mediated by improvements in attitude and by four of the six perceived benefits of physical activity. This suggests that the intervention was especially effective on awareness of the importance of a physically active lifestyle. However, the intervention also seemed to have been effective through the other measured psychosocial determinants, i.e. self-efficacy and social influence. These findings show that the strong cognitive behavioural component with an emphasis on psychosocial determinants of physical activity in the R&S and AaR interventions induced improvements in physical activity behaviour.

Another working mechanism of the intervention was through reducing the three highest rated barriers to physical activity, i.e. health conditions, lack of energy and limited environmental possibilities. The reduction of limited environmental possibilities as a barrier was probably caused by the suggested physical activity opportunities in the direct environment during the counselling sessions. The effect on the barriers health conditions and lack of energy could be due to the counselling for physical activities within each subject's possibilities, including health conditions and energy status. This led to a physical activity advice, which took these barriers into account and, consequently, made them less important barriers. However, health conditions and lack of energy as barriers were only important mediators on the short term, and not on the long term follow up measurement. This could be due to a reduction in these barriers on the longer term in the control group, caused by improved overall health over time. This would imply that these two barriers were reduced at an earlier stage in the intervention group, but that the control group caught up over time.

Unexpectedly, corrections of the basic model for lack of money and lack of transportation increased the intervention effect at T=1. Since more lack of money was associated with a higher physical activity score, it seems that a lack of money became more of a barrier for the subjects who became more active as a result of the interventions. Apparently, the more active subjects had actual physical activity costs, but these costs did not prevent them from being physically active even though the

costs were perceived as a barrier. This hypothesis was supported by the low average score for lack of money, indicating that this was only rarely perceived as a barrier. The combination of the R&S and AaR interventions increased the transportation problem of subjects on the short term, instead of reducing it. While trying to become more physically active, transportation to a physical activity location became a problem, which was not solved by the interventions. In contrast to a lack of money, these transportation problems actually hindered people to become more physically active on the short term. Fortunately, transportation problems were on average only seldom perceived as a barrier to physical activity and the interventions did not have a negative effect on transportation problems on the long term.

Although interpretation of the uncorrected determinant values in Table 2 is difficult, it seems that the determinants remained stable over time in the intervention group, whereas the determinants most often decreased in the control group after the end of rehabilitation. This suggests that these determinants had favourable values during in- or outpatient rehabilitation, but deteriorated after rehabilitation had been ended, unless this was prevented by the intervention.

Literature Perspective

The assessed determinants of physical activity have been documented repeatedly to be associated with physical activity in the general population, except for attitude towards physical activity behaviour, which does not seem to have an association with physical activity in the general population.[25] In the population of people with a disability much less is known about the determinants of physical activity. The few available studies suggest that the measured determinants are also important for physical activity behaviour in people with physical disabilities.[26-30] However, no studies were found on working mechanisms of effective physical activity promotion interventions in people with physical disabilities. The list of mediators corresponded well with the determinants of physical activity that were modelled in the earlier proposed Physical Activity for people with a Disability (PAD) model, which was based on the literature.[16] Consequently, the interventions successfully targeted modelled determinants of physical activity from the PAD model, which coincided with an improvement in physical activity behaviour. Thus, the PAD model appears to have

been a sufficient theoretical framework for this physical activity intervention trial in people with a disability.

The results of the current study are somewhat surprising when compared to physical activity interventions in other populations. Cognitive behavioural exercise interventions in the general population have been largely ineffective in improving physical activity behaviour,[31] and there seems to be little evidence for the effectiveness of stages of physical activity change based interventions in the primary care setting.[32] However, the R&S + AaR intervention had a strong cognitive behavioural component and especially the psychosocial determinants associated with this component were identified as mediators. Furthermore, the stages of physical activity change concept was thought to be a useful tool in the R&S + AaR intervention, providing some structure in the personalized tailored counselling. The most likely explanation of the probable effectiveness of the cognitive behavioural component and the stages of change concept within the current intervention is the difference in setting and population compared to the above mentioned studies.

It has been suggested that cognitive behavioural interventions in the healthy population should be combined with environmental interventions to be more effective in improving physical activity behaviour.[33,34] Although the current intervention had an environmental component, there seems to be room for improvement with respect to this component. The interventions mostly helped the subjects to cope with the existing environmental barriers rather than improve the environment with respect to factors, such as possibilities and transportation. Lack of sufficient environmental possibilities and transportation could be issues that need more attention, especially from policy makers.[33-35]

Limitations

A limitation of the applied analyses was the inability to add all mediators to the basic model at the same time. Because dummies had to be used for most variables, the number of variables in the model was high, with over 60 variables in the combined mediator analyses. Adding another mediator would bring eight more variables to the model, which would cause statistical power problems. Interpretation of the analyses has some limitations. The combined analysis on the T=1 data showed a reduction of the intervention effect of more than 100%, which was possible because determinants

that had an association opposite to the intervention effect were not added. However, interpretation of the percentages should be handled with care, since the used self-report questionnaires bring along possible information bias (e.g. recall bias). Furthermore, the cut-off value of ten percent to identify determinants that were associated with the intervention induced increase in physical activity behaviour was arbitrary. Although this cut-off value was also used in the earlier studies to identify confounders of the intervention effects,[14,15] the cut-off value should be interpreted with care, because determinants just below the cut-off value might be just as important as those just above it.

Another limitation in the interpretation of the results is that the intervention effect at T=2 was borderline significant (p=0.05) and higher than at T=1, where non-significant results were observed (p=0.16). However, the effects at both time moments were substantial enough to be considered as clinically relevant. Nevertheless, the non-significant intervention effect could have led to overestimation of the role of the determinants at T=1. To make sure that the results at T=1 showed the correct association between the determinants and the intervention effect on physical activity, the same analyses were repeated for the other measured physical activity outcome, i.e. whether or not subjects met the recommendation of being moderately physically active at least five days a week for 30 minutes per day.[3] For this outcome significant intervention effects were found both at T=1 and T=2.[14,15] These additional analyses showed similar, but lower results for the association between the determinants and the intervention induced effect on physical activity. The physical activity recommendation was a dichotomous outcome. Consequently, the physical activity recommendation was not as sensitive to change in determinants as the PASIPD, which led to the lower results. In conclusion, the analyses with the physical activity recommendation outcome showed the same associations between the determinants and the intervention effect on physical activity as the analyses with the PASIPD had shown. Consequently, the non-significant intervention effect on the PASIPD at T=1, did not lead to large misinterpretations of the results in the current study.

Finally, some of the determinants measured quite similar constructs. Social influence from family had a correlation higher than 0.8 with social influence from friends. The perceived benefits improved health and reduced risk of disease, better feeling about oneself, improved fitness, and improved daily functioning showed correlations of 0.6 - 0.7 between each other. Apparently, these determinants had

some overlap and increasing one will probably lead to some increase in the other as well. Thus, the positive effects of these determinants on physical activity behaviour do not add up cumulatively. This is well illustrated by the finding that the reduction of the intervention effect by the six strongest mediators at T=1 together (103%) was much lower than the sum of the individual reductions by these mediators (181%).

Conclusions

The current study gave some insights into the underlying mechanisms of the effective combination of the R&S and AaR interventions. The combined interventions improved several determinants of physical activity compared to the control group. Almost all psychosocial determinants as well as several barriers to physical activity were identified as mediators of the intervention induced improvements in physical activity behaviour. This study suggests that personalized tailored counselling interventions can improve physical activity behaviour in people with a disability by targeting both personal and environmental determinants of physical activity behaviour.

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Chapter 8

General discussion

The main purpose of this thesis was to determine the effectiveness of the sport stimulation intervention 'Rehabilitation & Sports' (R&S) alone and the effectiveness of the combination of R&S with the daily physical activity promotion intervention 'Active after Rehabilitation' (AaR) with respect to sport participation and physical activity behaviour for people with a physical disability after their rehabilitation. The secondary purpose was to take a closer look at the underlying working mechanisms of these interventions with a specific focus on determinants of physical activity. This general discussion will start with the conclusions that have been presented in chapters 2 through 7. Furthermore, methodological issues related to performing this multi-centre study are discussed. Finally, an overall conclusion and recommendations for practice, policy as well as for future research are formulated.

1. Main findings

The results of the large multi-centre trial, that was the backbone of this thesis, suggested that the combination of the R&S and AaR intervention programs significantly improved sport participation and physical activity behaviour in people with a disability, nine weeks (T=1) and one year (T=2) after the conclusion of their in- or outpatient rehabilitation (chapter 5 and 6). The R&S program alone did not have significant effects on sport participation and physical activity behaviour.

A closer look at possible underlying working mechanisms of the combination of the R&S and AaR interventions revealed that almost all measured psychosocial determinants as well as several barriers to physical activity could be identified as mediators of the intervention effects on physical activity behaviour (chapter 7). Determinants of physical activity that were identified as mediators of the observed intervention effects included: attitude, self-efficacy, social influence from family and from friends, the perceived benefits improved health and reduced risk of disease, better feeling about oneself, improved fitness and improved daily functioning, and the barriers limited environmental possibilities, health conditions and lack of energy. It should be noted that the exact causal relationship between the interventions, mediators and physical activity behaviour remains unclear.

This list of mediators included four of the six measured determinants of physical activity that were identified as correlates of physical activity behaviour during outpatient rehabilitation in chapter 4, namely attitude, self-efficacy and the barriers

health conditions and lack of energy. The list of mediators also corresponded well with the determinants of physical activity that were modelled in the earlier proposed Physical Activity for people with a Disability (PAD) model (figure 3, chapter 2), which was based on the existing literature. Consequently, the interventions successfully targeted modelled determinants of physical activity from the PAD model, which coincided with an improvement in physical activity behaviour. Figure 1 shows the variables of the PAD model that were measured in the multi-centre trial, with physical activity behaviour at the participation level. Except for gender and motivation, all other environmental and personal factors were identified as correlates of physical activity during outpatient rehabilitation and/or as mediators of the intervention effects. Unfortunately, the central determinant of physical activity, intention, was measured only in the stages of physical activity change questionnaire, from which intention to physical activity behaviour alone could not be derived. In conclusion, the PAD model seems to have been a good theoretical framework for this physical activity intervention trial in people with a disability.

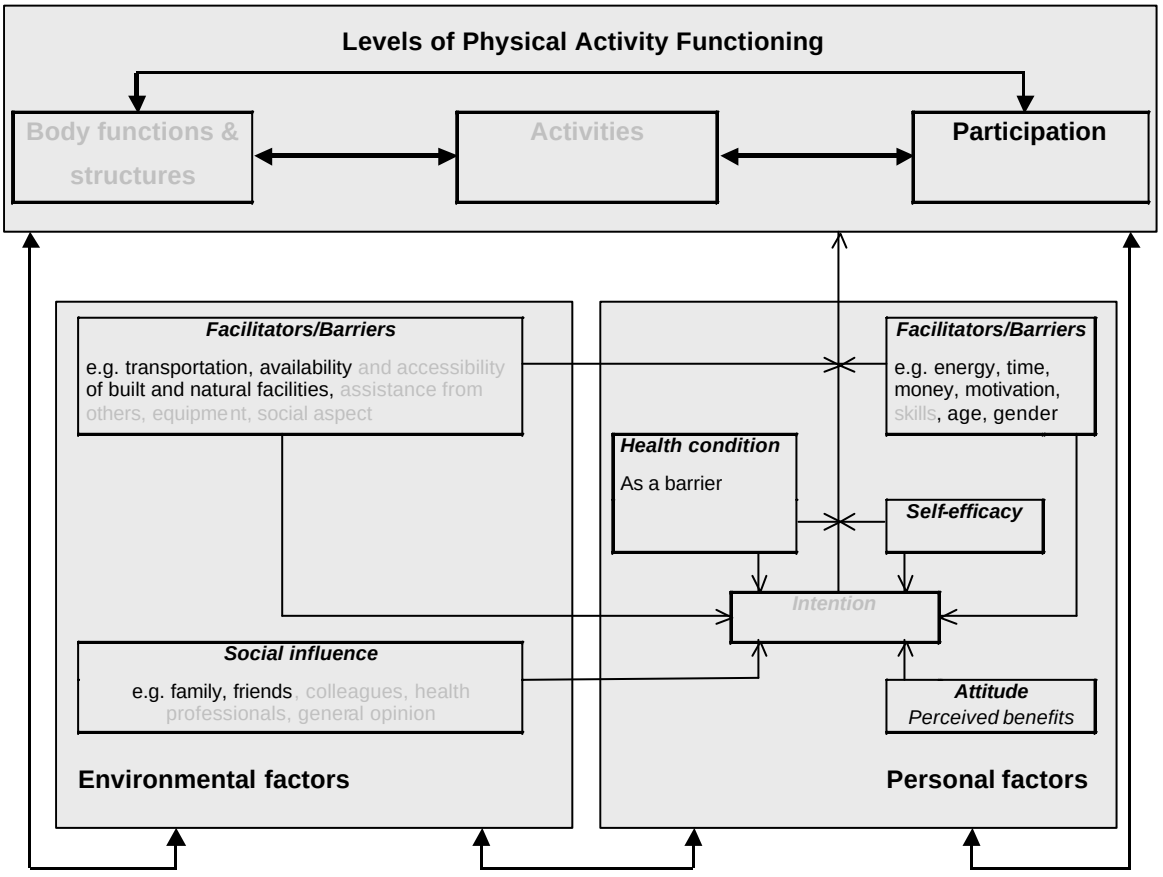

Figure 1: The PAD model with the variables that were measured in the multi-centre trial in black letters.

This thesis also provided some insights in issues regarding the measurement of physical activity behaviour in people with a disability. Chapter 3 showed that the main outcome of the multi-centre trial, the 'Physical Activity Scale for Individuals with Physical Disabilities' (PASIPD)[1] had test-retest reliability and criterion validity that was comparable to well established self-report physical activity questionnaires for the healthy population.

2. Working mechanisms and explanations

2.1 The effectiveness of the combined R&S and AaR interventions

There are several strengths in the combined R&S and AaR interventions, which might have been important in making the combination of these interventions effective. First, the content of the interventions was of course important. The interventions had a strong cognitive behavioural component as well as a strong focus on reducing barriers. The list of determinants of physical activity that were identified as mediators of the intervention effects on physical activity behaviour suggest that the cognitive behavioural component as well as the focus on reducing barriers were important components of the combined interventions.

Second, the use of personalized tailored counselling was certainly one of the strengths of both interventions, but especially for the AaR intervention. This counselling method arranges a dialogue between the counsellor and the participant, in which a best fit for the participant is discussed rather than top down solutions proposed by the counsellor. In this way physical activities that are also perceived by the participant to be the best fit for his or her needs and wishes can be identified, which is likely to maximize the chances of success. Furthermore, activities that are especially compatible with certain diagnoses or disabilities can be brought to the attention of the participant. This could help with the observed overcoming of barriers such as the persons' health condition or lack of energy. The stages of change concept of the Transtheoretical model,[2] which was also applied to physical activity behaviour,[3,4] provided a more structured component in the personalized tailored counselling of the AaR intervention. In this intervention subjects in different stages of physical activity were approached in a somewhat different stage-specific way and received different folder materials. The stages of change concept was a helpful tool that gave the counsellor a good opportunity to classify each subject with respect to

physical activity behaviour. Furthermore, it provided the necessary structure in the counselling sessions, while leaving enough flexibility for personalized tailoring.

Third, the counsellors and the participant searched for specific practical solutions, such as finding a nearby location for the physical activities that posed low barriers for participation. This practical component of the interventions most likely led to the reduction in the barrier limited environmental possibilities. This aspect of the intervention requires the counsellor to have good knowledge and documentation of the local possibilities with respect to environmental possibilities and transportation. This is especially important with respect to local sport and fitness clubs and their accessibility for people with different disabilities. However, the interventions left room for improvement with respect to both environmental possibilities and transportation. The interventions mostly helped the subjects to cope with the existing environments rather than to improve the environment with respect to possibilities and transportation. A lack of sufficient environmental possibilities remains an issue that needs more attention, especially from policy makers in the government and infrastructure companies.[5-7]

Fourth, by combining the R&S and AaR interventions a much wider range of possible physical activities could be discussed, which made it easier for the counsellors and the participants to find a suitable activity. Besides this, the AaR intervention also added daily physical activity opportunities that had lower participation thresholds than most sports. Comparison of the T=1 and T=2 results suggested that the combined interventions led to long term improvements in physical activity behaviour. Although, sport participation also improved in the longer term, the amount of time spent on sports seemed to decrease after the initial rise at T=1. This could suggest that daily physical activities were easier to integrate and maintain into daily life on the longer term than structurally participating in sport.

Fifth, the number and timing of counselling sessions is probably also important in these kinds of interventions. Especially the three AaR counselling sessions after the conclusion of the rehabilitation period probably were effective. During this period, subjects had to resume their everyday lives without help from health professionals and without the structured sport related activities that were part of the rehabilitation program. Counselling during this period is likely to have provided the necessary stimulus and may have helped to start or maintain sport and daily physical activities.

Future research has to shed a better light on the number, duration and timing of these counselling sessions.

2.2 The ineffectiveness of the stand-alone R&S intervention

As discussed in the previous section, possible explanations for the ineffectiveness of the stand-alone R&S program include its focus on 'just' sports, and the number and timing of its counselling sessions. The R&S intervention consisted of only two counselling sessions and most subjects received the first session only. The second session was after the conclusion of the rehabilitation period, which is believed to be an important time for counselling. However, this second session was short, not very interactive, and not many subjects received it. If the R&S intervention would have contained more, longer and more interactive check up sessions it might have been more effective.

Given these limitations of the R&S intervention, it seems that R&S as a stand-alone intervention was unable to add enough to the usual care rehabilitation treatment to have an effect on sport participation and physical activity behaviour. This notion is strengthened by the finding that 65% of the subjects in the control group stated to have received a sport advice from a health care professional, usually a rehabilitation physician or a physical therapist. This was similar to what subjects in the intervention group received from health professionals other than their intervention counsellor. Thus, usual care was similar in the control and intervention centres when it comes to sport advice from health professionals, and the R&S intervention was not strong enough to add significantly to this.

2.3 The effectiveness of a stand-alone AaR intervention?

The question of whether the AaR intervention without the R&S intervention could have been as effective as the combination of both interventions in improving sport participation and physical activity behaviour remains unanswered in this thesis. As discussed earlier, the major strength of the combination of the interventions is probably the focus on a wide range of physical activities, from walking the dog to playing wheelchair basketball. As a consequence, it seems the wisest for future cases to combine the R&S and AaR interventions into one single physical activity promotion intervention. Given the indication that the long-term results of the multi-

centre trial seemed to favour daily physical activity a little over sport participation, the best way to accomplish this would probably be to integrate a sport component into the AaR intervention. This would also be the most logical solution from a practical point of view, since the two R&S intervention sessions basically coincided with the first and third AaR intervention sessions. In conclusion, future research is needed to determine if AaR alone or a new intervention integrating R&S and AaR into one program can be as effective as the combination of the R&S + AaR interventions in improving sport participation and physical activity behaviour after rehabilitation.

3. Literature perspective

There is extensive literature on exercise training programs for people with a disability.[8-10] Even though the importance of the a physically active lifestyle for people with a disability has been frequently emphasized, much less research has been performed on physical activity behaviour in people with disabilities.[11-16] However, the few identified studies that evaluated individualized tailored counselling based physical activity promotion programs for people with disabilities showed promising results. An exercise counselling program for people with type 2 diabetes, consisting of two stage of change tailored 30-min exercise counselling sessions and four follow up support phone calls, improved physical activity behaviour in a randomised controlled trial (n=70).[17] Another randomised controlled trial among people with type 2 diabetes (n=340), showed that multiple individual behavioural counselling sessions improved physical activity behaviour.[18] One exercise consultation during phase IV cardiac rehabilitation was reported to improve short term self-reported leisure physical activity among 31 subjects in a randomised controlled trial.[19] Finally, in a randomised controlled trial in women with mobility limitations, a physical activity promotion program improved self-reported physical activity.[20] However, the last mentioned results are questionable, since the data were derived from the weekly physical activity logs that were part of the intervention and comparable data were not available for the control group.

These studies mentioned above suggest that physical activity promotion interventions using individualized tailored counselling in populations of people with a chronic disease or physical disability can be effective in improving physical activity behaviour. It should be stated though that no systematic literature review was carried

out for this kind of interventions, and consequently other studies may have been overlooked. There is also the risk of publication bias, where studies on ineffective interventions are not being reported in the literature.[21,22] Furthermore, all studies were performed in somewhat different settings and with different populations, compared to our multi-centre trial. All reviewed studies only measured the effect of their interventions during the first three months after the last intervention session. However, given these limitations, it can be concluded that the reported literature shows agreement with the main finding of our multi-centre trial, i.e. that individualized tailored counselling interventions can be effective in improving physical activity behaviour in people with a chronic disease or physical disability.

The literature does not provide insights into the underlying working mechanisms of effective interventions. Although some information exists on determinants of physical activity in people with a physical disability,[23-26] it has not been reported which determinants could be targeted effectively by interventions in order to improve physical activity behaviour in this population.

The results of the current study are somewhat surprising when compared to physical activity interventions in other populations. Cognitive behavioural exercise interventions in the general population have been largely ineffective in improving physical activity behaviour,[27] and there is little evidence for the effectiveness of stages of physical activity change based interventions in the primary care setting.[28] However, the R&S + AaR intervention had a major cognitive behavioural component and especially the psychosocial determinants associated with this component were identified as mediators. Furthermore, the stages of physical activity change concept was found to be a useful tool in the R&S + AaR intervention, providing some structure in the personalized tailored counselling. The most likely explanation of the probable effectiveness of the cognitive behavioural component and the stages of change concept within the current intervention is the difference in setting and population compared to the above mentioned studies.

4. Methodological issues

4.1 Study design & randomisation

In 1997 the R&S program was started in nine Dutch rehabilitation centres. In order to evaluate the effectiveness of this program in its original and existing form, the current

multi-centre trial was started in 2000. Four of these nine original R&S centres were included in the trial, and served as the intervention centres. A control group was selected from six rehabilitation centres, which did not participate in the R&S program and only provided usual care. At the start of the trial the daily physical activity promotion intervention AaR was designed, which was additional to the R&S program. Participants in the intervention centres were randomly allocated to a group receiving just R&S and a group receiving the combination of R&S and AaR. Both intervention groups were compared to the non-randomly allocated control group, making this multi-centre trial quasi-experimental. A randomised controlled trial would have been a methodologically better design. However, this was a practical impossibility, because the R&S intervention needed to be evaluated in its original and existing form. Since all subjects in the intervention rehabilitation centres were offered R&S already, it would have been unethical to deny subjects R&S in order to recruit them for a control group. Consequently, subjects for the control group had to be recruited from rehabilitation centres that did not participate in the R&S intervention.

The quasi-experimental design resulted in differences between the intervention and control population with respect to treatment form, duration of treatment, total time of sport related activities during treatment, time between baseline and end of rehabilitation, education, and diagnosis. The analyses described in chapters 5-7 identified these variables as confounders of the intervention effects and all these variables were corrected for in the results that were reported in these chapters. In these three chapters multilevel analyses were performed in order to correct for possible clustering of patient data within rehabilitation centres.[29,30] Furthermore, all longitudinal analyses were corrected for the baseline value of the outcome variable, thus correcting for possible baseline differences between the interventions and control groups, as well as for possible regression to the mean effects. Finally, the analyses that were used to determine the effectiveness of the R&S and AaR interventions were checked for possible effect modification from age and gender. By using all these statistical corrections, the lack of a randomisation procedure for the interventions and control groups was compensated for as much as possible. However, these corrections led to some loss of statistical power.

The randomisation within the intervention group was performed successfully, except in one of the four intervention rehabilitation centres. No AaR counsellor was available for the final 18 subjects who were included in this centre. Consequently, these

subjects had to be allocated to the R&S group. This partly explains the difference in the number of subjects in the R&S group compared to the R&S + AaR group. The remainder of the difference in the number of subjects between the intervention groups can be explained by the fact that the randomisation envelops were filled per ten, such that every ten envelops contained five letters for each group. However, it seems unlikely that this small failure in the randomisation procedure led to selection bias. This belief is supported by the lack of observed differences in personal characteristics between the R&S group and the R&S + AaR group.

4.2 Selection of participants

The selection of subjects for the multi-centre trial is described in figure 1 of chapter 5. Selection bias may have occurred when subjects were assessed for eligibility. All subjects who were treated in the participating rehabilitation centres during the inclusion period were supposed to be assessed for eligibility for this multi-centre trial. However, the total number of subjects treated in the rehabilitation centres during this period was probably higher, since assessment for eligibility was dependent on local circumstances and did not function equally well in all centres. Given the rough estimation made prior to the trial on the expected number of patients, it is believed however that the larger part of the patients was assessed for eligibility.

Selection bias could have occurred also when the participants for the study were selected. This selection led to the exclusion of two-thirds of the subjects that were assessed for eligibility. The largest part was excluded for not meeting the inclusion criteria, or for meeting the exclusion criteria. This occurred most frequently because of not meeting the inclusion diagnoses, or insufficient cognitive or language abilities. The only exclusion criterion that might have been the cause of a serious selection bias was ‘no interest in sport participation at all’. However, less than four percent of all excluded subjects were excluded because of this criterion. Another concern was the number of subjects who refused to participate in the trial, which was eight percent of those excluded. Research has suggested that people who participated in health promotion programs were more committed to healthy lifestyles than those who did not participate.[31] This suggests that subjects, who refused to participate, possibly were less susceptible to the intervention effects, which may have caused selection bias. It seems unlikely that the group of subjects that was excluded because they

were not timely approached caused selection bias. These exclusions were caused by logistic and planning problems in the rehabilitation centres. This most likely led to random exclusions. Finally, the group of people excluded without a recorded reason could have caused selection bias. This group often lacked a recorded reason, due to problems with the registration systems in some of the rehabilitation centres. Given the assumption that these problems were not associated with subject characteristics, the distribution of exclusion reasons in this group was most likely similar to the rest of the excluded subjects. In conclusion, the multi-centre trial may have been subject to some selection bias. This may have had some effect on the generalizability of the results. However, selection probably did not lead to biased results within the studied population, since it seems unlikely that selection bias differed between in the intervention and control centres.

4.3 Blinding

In the multi-centre trial the research assistants in the intervention centres who performed the measurements were blinded to which intervention group the subjects were allocated. Obviously, the subjects were not blinded to which group they were allocated, nor were the intervention counsellors. This may have led to bias in the observed results, due to a social desirability effect.[32] The subjects in the intervention group may have reported higher physical activity and sport levels than their actual levels, because they might have felt these higher levels were expected from them. Such a social desirability effect could have led to an overestimation of the intervention effects. However, if this was the case, there probably also would have been such an effect in the R&S only intervention group, while this group showed no differences in the outcome measures at T=1 and T=2 when compared to the control group. Furthermore, it was emphasized to the participants that the data analysis was anonymous. Also, the measurements at T=1 and T=2 were carried out at home and for the measurements there was telephone contact with the research assistant, who was not involved in the interventions. This way of operating probably reduced the risks on socially desirable answers. Finally, the intervention effects on sport participation and physical activity behaviour were still present 12 months after the end of rehabilitation, which was approximately 10 months after the last intervention

session. It is plausible to conclude that social desirability did not play a role anymore after this time interval.

Another problem of the lack of sufficient blinding may have been the influence of the research assistants on the participants during the measurements. However, as mentioned above the research assistants were not involved in the interventions and there was little contact between participants and research assistants at T=1 and T=2. Furthermore, the research assistants in the intervention centres were blinded to which interventions the subjects received. Thus, if this kind of bias had taken place, it should also have been manifested in the R&S only group, and not just in the R&S + AaR group.

These problems of possible bias due to the lack of sufficient blinding could have been prevented by giving the control group some kind of placebo treatment. Such a placebo treatment would make the blinding of the participants, the intervention/placebo counsellors, as well as a better blinding of the research assistants possible. However, integrating a placebo treatment in this kind of large-scale behavioural intervention research is difficult and expensive, and this was a practical impossibility in this case.

4.4 Compliance, lost to follow up & timing

Compliance with the interventions was between 55%-67% depending on the on treatment definitions used at the different measurement moments and the received interventions. This poor compliance was mostly due to logistic and personnel problems, especially in one of the four intervention centres. Due to these problems many subjects never received their intervention. Only few people stopped with their intervention because it was too demanding or not to their liking. Without the logistic and personnel problems compliance would probably have been higher. Because of the poor compliance, the on treatment analyses were added in order to allow better evaluation of the interventions.

Lost to follow up was an acceptable twenty percent over the whole study period, but was higher in the intervention groups than in the control group. However, this difference between the intervention and control groups was mostly due to the mentioned logistic and personnel problems. Without these problems, lost to follow up in the intervention centres would probably have been similar to the twelve percent

that was recorded for the control centres. This also would suggest that few people dropped out because the measurements or the interventions were too demanding or not to their liking. Furthermore, the lost to follow up caused by the logistic and personnel problems most likely did not cause any selective lost to follow up, since it was not person specific. The remainder of the lost to follow up might have caused some selective lost to follow up, but it is unlikely that this has led to a substantial problem due to the small number of subjects in this category.

The logistic and personnel problems, as well as problems with reaching the subjects by telephone, also had a negative effect on the timing of the measurements and interventions, which did not always follow the correct time path that is shown in figure 2. As a consequence, especially the order of the intervention sessions and the T=1 measurement sometimes got mixed up, and subjects ended up receiving the T=1 measurement while the intervention was still in progress. In the on treatment definitions this was taken into account by defining the number of intervention sessions received before the T=1 measurement that was needed to be included in the on treatment analyses. These procedures may have led to an underestimation of the interventions effects, since subjects who received only part of the intervention were included in the analyses. Another consequence of the above mentioned problems was that some subjects received their T=1 measurement much later than planned, after the interventions had ended. This was the reason why the time between the last intervention session and one year follow up had to be shorter than 120 days in the T=1 on treatment analyses. Fortunately, timing problems were much less frequent at T=2. On average all the time intervals between the intervention sessions and the measurements were as intended beforehand.

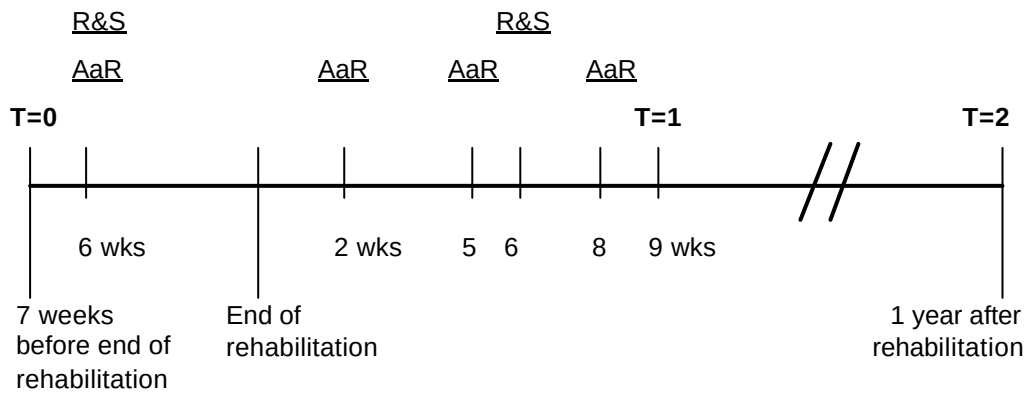

Figure 2: The time path of the multi-centre trial, including the R&S and the AaR interventions and the three measurement moments (T=0, T=1 and T=2).

Another difficulty was the timing of the baseline measurement. Baseline measurement at the start of rehabilitation was not a good option, because the duration of treatment differed so much between subjects. The chosen time of 7 weeks before the end of rehabilitation gave two problems. First, determining the last day of rehabilitation approximately two months in advance was difficult and led to variations in the actual time between baseline and the end of rehabilitation. In the analyses correction for this time difference appeared to be necessary. Second, at this baseline measurement some people had been participating already in some form of rehabilitation centre facilitated sport activities. This phenomenon possibly happened more frequently in the more sport orientated intervention centres. This would explain the higher baseline number of people participating in sport in the intervention groups compared to the control group, while the number of people who participated in sport in the year before rehabilitation was equal in all groups. Multilevel analyses with sport participation (or score) in the year before rehabilitation and without sport participation (or score) at baseline showed higher and more significant odds ratios in both intervention groups compared to the control group. Thus, correcting for baseline values may lead to an underestimation of the effect of both interventions on sport participation and sport score, because baseline values for both sport outcomes were already higher in the intervention groups. It should be noted though that these baseline sport outcome values were not corrected for any of the observed baseline differences in personal characteristics between the intervention and control group.

4.5 Outcome measures

One of the limitations of the multi-centre trial was the use of self-reported outcomes. The four main outcomes that assessed sport and physical activity participation were not golden standards, and were susceptible to social desirability and recall bias.[33-35] However, no good alternatives exist to measure physical activity behaviour in such a large population. The problem of possible social desirability was discussed in detail in paragraph 4.3. Recall was never over periods longer than a week (except for sport in the year before rehabilitation) and patients were only included in the study if they had sufficient cognitive abilities.

For the measurement of physical activity in people with a disability, only two population specific questionnaires were found in the literature, one of which was the

in this thesis used PASIPD.[1,36] No outcome measures were found for sport participation. As a consequence, the 'meeting the physical activity recommendation' outcome was assessed with an existing questionnaire,[37] which was designed for another purpose. The two sport outcomes were newly designed for the current study, although for the sport score the intensity category of each sport was estimated with the use of the physical activity compendium for the healthy population.[38] Of all four main outcomes of the multi-centre trial, only the psychometric qualities of the PASIPD have been studied. These qualities were shown to be similar to well established self-report physical activity questionnaires for the healthy population (chapter 3). Although, the other outcomes have some connection with existing literature, their psychometric qualities have been insufficiently researched and remain questionable. The lack of sufficiently researched measurement tools was also the reason why four different outcome measures were used for quite similar outcomes. Fortunately, all four outcomes showed similar effects of the evaluated interventions. Obviously, more research is needed to establish better validated outcome measures for sport participation and physical activity behaviour in people with a disability.

4.6 Statistical power

A limitation of the current study was the possible lack of statistical power. The power analysis prior to the start of the trial revealed that around 2000 subjects (1000 in the intervention and 1000 in the control group) were needed to have sufficient statistical power to demonstrate a significant 10% change in the PASIPD (power=80%, p=0.05, lost to follow up=20%). However, only 1202 subjects were included and the intervention group was divided into two groups, which was also not accounted for in the initial power analysis. As a consequence especially the intervention groups contained far less subjects than was estimated prior to the trial. Fortunately, the effects of the R&S + AaR interventions on the PASIPD were higher than 10% and did show some significant results. This also illustrates the inaccuracy of the power analyses, which was mostly due to the unfounded assumptions it was based on. However, a larger sample of subjects would have increased the statistical power, and possibly would have led to more statistically significant results.

5. Generalizability

The inclusion and exclusion criteria obviously made the study population differ from the general rehabilitation population. The applicability of the R&S + AaR interventions to those who were excluded because of insufficient cognitive or language abilities to participate, medical contra-indications, a terminal or very progressive disease, or because they had no interest at all in sport participation is highly questionable. Although the group of people who had no intention to become more physically active is a group that would probably benefit from a more active lifestyle, the effectiveness of the R&S + AaR interventions for this group remains questionable. The results of the multi-centre trial can probably be generalized to all other rehabilitation patients, who would meet the inclusion and exclusion criteria of this study. Furthermore, rehabilitation patients with diagnoses that were excluded in the current study, such as heart and lung diseases, could probably also benefit from the R&S + AaR interventions, given the ability to tailor the interventions to specific personal situations and needs. This is supported by the findings of the studies reported in paragraph 3 on personalized tailored counselling in other populations.[17-19]

Although this thesis suggests that physical activity promotion in the rehabilitation setting can be successful, it should be noted that the Dutch rehabilitation centres probably differ from the centres in other industrialized countries. Dutch rehabilitation centres have a mix of in- and outpatients, usually with more outpatients. Since the Netherlands is a small country, with a total of 24 rehabilitation centres and a good infrastructure, travelling time to a rehabilitation centre is usually less than an hour. As a result, outpatients can visit the centre five days a week for treatment. So even for outpatients, rehabilitation treatment can be intensive. Furthermore, the length of stay in inpatient rehabilitation is overall relatively long compared to for instance Australia and the US.[39] In other countries patients usually might start in a rehabilitation centre and than go to a local physiotherapist, whereas Dutch patients often follow their entire rehabilitation treatment in a rehabilitation centre. In conclusion, in the Dutch situation, rehabilitation centres play a major role in rehabilitation of both inpatients and outpatients, and as a consequence these rehabilitation centres were locations that facilitated the intervention programs. In countries where rehabilitation centres play a different role, comparable interventions might not be as effective as in the reported trial.

6. Final conclusions and recommendations

This thesis showed that it is possible to obtain a long lasting improvement in physical activity behaviour by using physical activity promotion programs in the rehabilitation setting, consisting of several personalized tailored counselling sessions focusing on both personal and environmental factors. Studies reported in the literature suggest that similar physical activity promotion interventions using individualized tailored counselling in other settings and aiming at populations of people with a chronic disease or physical disability can also be effective in improving physical activity behaviour. This thesis also provided some useful insights in working mechanisms of such interventions, in the theoretical context as well as in some measurement issues.

6.1 Recommendations for future research

Although this thesis gave insights in promoting physical activity behaviour in people with a physical disability with a special focus on the rehabilitation setting, many questions remain unanswered. This leads to the following recommendations for future research.

-The measurement of physical activity behaviour in people with a disability needs special attention, since this is still an underdeveloped area. This area is crucial to the adequate evaluation of interventions. Besides the validation of questionnaires against a golden standard such as doubly labelled water, the search for a more objective measure of physical activity, which is applicable in large intervention studies should be continued.

-More information is needed on the effects of a physically active lifestyle for people with disabilities with respect to functioning and health.

-More research is needed concerning the duration, frequency, intensity, and form of physical activity that is beneficial for the health of people with a disability. It should be taken into account that the optimal duration, frequency, intensity, and form of physical activity most likely differs between disability types and individuals.

-The validity and applicability of the formulated PAD model needs further studying.

-More research is needed to identify the important personal and environmental determinants of physical activity behaviour in people with a disability.

-The working mechanisms of interventions should be researched better, in order to assess the causal pathway through which interventions can be effective. This knowledge would be helpful to improve existing interventions and to design new interventions.
-Some fine-tuning of the studied interventions could lead to more effective results. For example, future research has to find out what the effects of the AaR intervention alone would be on physical activity behaviour. And thus answer the question if R&S and AaR should be integrated or if the AaR alone would be sufficient, without a special focus on sport participation.
-Future research has to show if the R&S + AaR intervention is more effective in specific subgroups, such as different diagnoses or treatment forms (in- and outpatient).
-To further optimise interventions a better insight is needed in the dose-response relationship between the number, duration and timing of counselling telephone calls, and improvements in physical activity behaviour.
-Future research should determine the effects of the combined R&S + AaR interventions on functioning and health outcomes.
-Knowledge about the cost effectiveness of the R&S + AaR intervention would make the decision to implement it into practice easier.
-Future research also has to show if the R&S + AaR intervention can be effectively translated into interventions in other settings and populations of people with a disability or chronic disease.

6.2 Implications for rehabilitation & society

It has been estimated that around 13 to 20% of the western population has one or more disabilities. In the coming decades the ageing of the population will lead to an increase in the absolute number of people with a disability. Physical inactivity is a frequent problem in this growing population of people with a disability, which leads to problems with functioning and increased risks on secondary health problems, including coronary artery disease, diabetes, colon cancer and osteoporosis. An improvement in physical activity behaviour in this population is not only likely to improve everyday functioning and reduce the risks of secondary health problems, but could also lead to a reduction in medical consumption. This thesis showed that a

rehabilitation based intervention was able to increase physical activity behaviour after rehabilitation. The structural implementation of such an intervention in rehabilitation as well as translation of this successful intervention to other settings and populations of people with a disability or chronic disease will likely improve the physical activity behaviour of the participants. On the longer term, this could possibly increase the average daily physical activity level in the whole population of people with a disability, which might improve overall health and reduce medical consumption in this population.

Since the main goal of rehabilitation is to make people learn to live in society as independent as possible with their disability, the effective promotion of a physically active lifestyle should be a significant part of rehabilitation treatment. However, it also seems of general societal interest to promote physical activity behaviour in people with a disability who do not participate in rehabilitation treatment.

With respect to practice and policy the following recommendations can be made.

-The combination of the R&S and AaR interventions should be implemented in the Dutch rehabilitation centres. The Dutch government, insurance companies, rehabilitation centres and the Netherlands Sports Organization for People with a Disability (NebasNsg) should explore ways to finance this effective combination of interventions.

-Attempts should be made to translate the results of the current thesis into effective new interventions to promote physical activity behaviour for other countries, settings and populations of people with a disability or chronic disease. For the designing of such new interventions the following recommendations can be formulated:

- -Personalized tailored counselling is preferred.
- -The stages of change concept can be useful for personalized tailored counselling.
- -Multiple intervention sessions are preferred.
- -The interventions should target both personal and environmental factors.

-The current thesis showed that the existing R&S intervention program was not effective in its existing form. However, an effective alternative was provided consisting of the combination of the R&S and AaR interventions, which should now lead to adjustments in policy and practice. In conclusion, it remains important to strive for evidence-based rehabilitation medicine as well as preventive medicine, and

the collaboration between policy, practice and research remains essential to achieve this.

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English summary

Promoting physical activity in the rehabilitation setting

The health benefits of a physically active lifestyle are well known in the general population. For people with a physical disability a physically active lifestyle could improve every day functioning, reduce disability and reduce the risk of secondary health problems. However, people with a disability are in general even less physically active than the general population. As a consequence there is need to improve physical activity behaviour in people with a disability. This thesis discussed theoretical and measurement issues of physical activity behaviour in people with a disability, as well as presented the results of a large multi-centre physical activity promotion intervention trial, which was performed in the rehabilitation setting.

Theoretical framework

In chapter 2 a systematic literature search for articles considering physical activity behaviour, disability and models relating both topics in particular was performed. However, no models were found relating physical activity behaviour, its determinants and functioning, in people with a disability. Consequently, a new model was constructed based on existing models of disability and models of determinants of physical activity behaviour. The proposed conceptual model, the 'Physical Activity for people with a Disability model' (PAD model), describes the relationships between physical activity behaviour, its determinants and functioning of people with a disability. This model formed the theoretical framework of this thesis.

Measuring physical activity

Chapter 3 discusses the measurement of physical activity behaviour in people with a disability. The main purpose of this chapter was to determine the test-retest reliability and the criterion validity of the Physical Activity Scale for Individuals with Physical Disabilities (PASIPD), which is a 7-day recall physical activity questionnaire. Fortyfive non-wheelchair dependent subjects with stroke, neurological disorders, orthopedic disorders, spinal cord injury, back disorders, chronic pain, or whiplash were recruited from three Dutch rehabilitation. In order to determine the test-retest reliability, subjects filled in the PASIPD twice, one week apart. During this week subjects wore a MTI/CSA and a RT3 accelerometer in order to determine criterion validity. The test-retest reliability Spearman correlation coefficient of the PASIPD was 0.77. The Spearman correlation for criterion validity was 0.30 and 0.23 when compared to the

MTI/CSA and the RT3 accelerometer, respectively. These correlations for test-retest reliability and criterion validity were similar to those reported in studies of well established self-report physical activity questionnaires for the general population. The PASIPD was the main outcome of the multi-centre trial that will be discussed next.

Multi-centre intervention trial

Adult in- and outpatients from ten Dutch rehabilitation centres with either amputation, stroke, neurological disorders, orthopaedic disorders, spinal cord injury, rheumatic related disorders, back disorders, chronic pain or whiplash participated in this trial. Subjects in four intervention rehabilitation centres were randomised into a group receiving the sport stimulation program 'Rehabilitation & Sports' (R&S) only (n=315) and a group receiving R&S combined with the daily physical activity promotion program 'Active after Rehabilitation' (AaR) (n=284). Both interventions were based on personalized tailored counselling. Subjects in six control rehabilitation centres (n=603) received usual care. Questionnaires were administered at seven weeks before (T=0), nine weeks after (T=1) and one year after the end of rehabilitation (T=2).

Chapters 5 and 6 reported the effects of the R&S intervention alone and of the combined R&S and AaR interventions on sport participation and physical activity behaviour, at T=1 and T=2, respectively. At T=1, intention to treat multilevel analyses in the R&S + AaR group showed significant improvements in one sport ($p=0.02$) and one physical activity outcome ($p=0.03$). Furthermore, on treatment analyses in the R&S + AaR group showed significant improvements in both sport outcomes ($p<0.01$ and $p=0.02$) and one physical activity outcome ($p<0.01$). Intention to treat analyses at T=2 in the R&S + AaR group showed (borderline) significant improvements in one sport ($p=0.02$) and both physical activity outcomes ($p=0.01$ and $p=0.05$). The T=2 on treatment analyses in the R&S + AaR group showed similar, but stronger effects. The R&S intervention alone showed no significant changes in any of the analyses at T=1 and T=2. In conclusion, only the combination of the R&S and AaR program improved sport participation and physical activity behaviour nine weeks and one year after in- or outpatient rehabilitation.

Correlates and mediators of physical activity behaviour

Chapter 4 identified correlates of physical activity behaviour in the included outpatients at T=0. Multiple linear regression analysis revealed that being younger, having children living at home, participating in paid/volunteer work and/or education, smoking, a shorter total treatment period, more sport related activities during the treatment period, higher self efficacy and/or better attitude towards physical activity, experiencing health conditions and lack of energy less frequently as barriers to physical activity behaviour, and lack of time and money, were significantly correlated with the PASIPD score.

Finally, chapter 7 took a closer look at the working mechanisms behind the combination of the R&S and AaR interventions, with specific focus on determinants of physical activity. Determinants that were identified as mediators of the interventions induced improvements in physical activity behaviour at both T=1 and T=2 were attitude, the perceived benefits improved health and reduced risk of disease, better feeling about oneself and improved fitness, and the barrier limited environmental possibilities. Self-efficacy, social influence from family and from friends, the perceived benefit improved daily functioning, and the barriers health conditions and lack of energy were also identified as mediators, but at only one measurement moment. Opposite associations at one of the measurements were observed for the barriers lack of money, lack of energy, and transportation problems. In conclusion, the combination of the R&S and AaR interventions improved several psychosocial determinants and barriers to physical activity in the intervention group, compared to the control group nine weeks and one year after rehabilitation. These improvements were related to the earlier reported increases in physical activity behaviour.

General discussion of the results

The final chapter was the general discussion, in which it was concluded that this thesis showed that it is possible to obtain a long lasting improvement in physical activity behaviour by using physical activity promotion programs, consisting of several personalized tailored counselling sessions focusing on both personal and environmental factors, during and after rehabilitation. Studies reported in the literature suggest that similar physical activity promotion interventions using

individualized tailored counselling in other settings and populations of people with a chronic disease or physical disability can also be effective in improving physical activity behaviour. This thesis also provided some useful insights in the working mechanisms of such interventions, the underlying theory as well as in some measurement issues. Chapter 8 also discussed some methodological issues, and formulated recommendations for practice, policy as well as for future research.

Nederlandse samenvatting

Het bevorderen van bewegingsgedrag tijdens en na revalidatie

De voordelen van een lichamelijk actieve leefstijl voor de gezondheid van de bevolking in haar algemeenheid zijn goed gedocumenteerd. Voor mensen met een lichamelijke beperking zou een lichamelijk actieve leefstijl een positief effect hebben op hun dagelijkse functioneren. Daarnaast zou de kans op secundaire gezondheidsproblemen daardoor worden verkleind. Mensen met een lichamelijke beperking zijn echter - algemeen genomen - nog inactiever dan mensen zonder een lichamelijke beperking. Het is dan ook juist voor deze groep extra belangrijk om ze lichamelijk actiever te krijgen. Dit proefschrift behandelt theoretische en klinimetrische kanten van bewegingsgedrag bij mensen met een lichamelijke beperking. Daarnaast worden de resultaten van een groot interventieonderzoek gepresenteerd dat werd uitgevoerd in tien Nederlandse revalidatiecentra.

Theoretisch model

In hoofdstuk 2 is systematisch gezocht naar literatuur over lichamelijke activiteit en fysieke beperkingen, en vooral naar modellen die beide onderwerpen integreren. Er werden geen modellen gevonden die bewegingsgedrag, determinanten van bewegingsgedrag en functioneren samenbrachten. Daarom werd een nieuw model samengesteld op grond van bestaande modellen over fysieke beperkingen en functioneren, en op grond van modellen over determinanten van bewegingsgedrag. Het voorgestelde model - het ‘Physical Activity for people with a Disability model’ (PAD-model) - beschrijft de relatie tussen bewegingsgedrag, determinanten van bewegingsgedrag en functioneren voor mensen met een lichamelijke beperking. Het PAD-model vormt de basis van dit proefschrift.

Het meten van bewegingsgedrag

In hoofdstuk 3 wordt het meten van bewegingsgedrag besproken bij mensen met een lichamelijke beperking. Hoofddoel was om de test/hertest-betrouwbaarheid en de criteriumvaliditeit te bepalen van de ‘Physical Activity Scale for Individuals with Physical Disabilities’ (PASIPD). Vijfenveertig mensen, die niet afhankelijk waren van een rolstoel, werden gerekruteerd uit drie Nederlandse revalidatiecentra. Bij de deelnemers waren de volgende diagnoses vastgesteld: CVA, neurologische aandoening, orthopedische aandoening, dwarslaesie, rugaandoening, chronische pijn of whiplash. Om de test/hertest-betrouwbaarheid te kunnen bepalen vulden de

deelnemers tweemaal de PASIPD in met een week tussentijd. Om de criteriumvaliditeit te bepalen droegen de deelnemers tijdens die week een MTI/CSA-accelerometer en een RT3-accelerometer. De Spearman-correlatie voor de test/hertest-betrouwbaarheid van de PASIPD had een waarde van 0,77. De Spearman-correlaties voor de criteriumvaliditeit hadden waarden van 0,30 en 0,23 voor respectievelijk de vergelijking met de MTI/CSA- en de RT3-accelerometer. Deze correlaties voor de test/hertest-betrouwbaarheid en voor de criteriumvaliditeit waren vergelijkbaar met de waarden die zijn gevonden bij algemeen aanvaarde, zelfrapportage vragenlijsten aangaande bewegingsgedrag in de bevolking in haar algemeenheid. De PASIPD was de belangrijkste uitkomstmaat in de interventiestudie die nu zal worden besproken.

Interventiestudie

De deelnemers aan de interventiestudie waren volwassen klinische en poliklinische patiënten uit tien Nederlandse revalidatiecentra met de volgende diagnoses: amputatie, CVA, neurologische aandoening, orthopedische aandoening, dwarslaesie, reumatisch gerelateerde aandoeningen, rugaandoening, chronische pijn of whiplash. De deelnemers in vier interventie-revalidatiecentra werden willekeurig verdeeld over een groep die alleen het sportstimuleringsprogramma 'Revalidatie & Sport' (R&S) ontving (n=315) en een groep die R&S, aangevuld met het dagelijkse lichamelijke activiteitstimuleringsprogramma 'Actief na Revalidatie' (AnR), ontving (n=284). Beide interventieprogramma's bestonden uit op de persoon toegespitste counseling. De deelnemers in zes controle-revalidatiecentra ontvingen uitsluitend de gebruikelijke revalidatiebehandeling (n=603). De vragenlijsten werden afgenomen zeven weken vóór de revalidatie (T=0), negen weken erna (T=1) en ten slotte een jaar erna (T=2).

In de hoofdstukken 5 (voor T=1) en 6 (voor T=2) worden de effecten beschreven van de R&S interventie - alléén en in combinatie met de AnR interventie - op twee uitkomstmaten voor sport en twee uitkomstmaten voor bewegingsgedrag in het algemeen. De 'intention to treat' multilevel analyses voor T=1 lieten in de R&S + AnR groep significante verbeteringen zien op één uitkomstmaat voor sport ($p=0,02$) en op één uitkomstmaat voor bewegingsgedrag in het algemeen ($p=0,03$). Verder lieten de 'on treatment' analyses voor T=1 in de R&S + AnR groep significante verbeteringen zien op beide uitkomstmaten voor sport ($p<0,01$ and $p=0,02$) en op één uitkomstmaat

voor bewegingsgedrag in het algemeen ($p<0,01$). De 'intention to treat' analyses voor T=2 lieten voor de R&S + AnR groep (marginaal) significante verbeteringen zien op één uitkomstmaat voor sport ($p=0,02$) en op beide uitkomstmaten voor bewegingsgedrag in het algemeen ($p=0,01$ and $p=0,05$). De 'on treatment' analyses voor T=2 lieten dezelfde, maar sterkere effecten zien. De R&S interventie alléén liet in geen enkele analyse significante veranderingen zien, noch voor T=1 noch voor T=2.

Samenvattend kan worden geconcludeerd dat de combinatie van de R&S en de AnR interventies sportdeelname en algemeen bewegingsgedrag verbeterde, zowel negen weken als een jaar na het einde van de klinische of poliklinische revalidatie.

Verbanden en mechanismen van bewegingsgedrag

In hoofdstuk 4 zijn variabelen geïdentificeerd die significant correleerden met bewegingsgedrag van de poliklinische patiënten voor T=0. Multiple lineaire regressieanalyse liet zien dat de volgende factoren significant correleerden met de PASIPD-score: een jongere leeftijd, kinderen hebben, betaald of als vrijwilliger werken of studeren, roken, een kortere revalidatiebehandeling, meer sport activiteiten tijdens de revalidatiebehandeling, een hogere eigen effectiviteit, een betere attitude ten opzichte van bewegingsgedrag, gezondheidsproblemen en gebrek aan energie minder vaak zien als een barrière om te bewegingen, gebrek aan tijd en gebrek aan geld.

In hoofdstuk 7 is verder gekeken naar de mogelijke werkingsmechanismen van de gecombineerde R&S en AnR interventies, waarbij de nadruk lag op determinanten van bewegingsgedrag. Determinanten die werden geïdentificeerd als mediators van de interventie effecten op bewegingsgedrag voor T=1 en T=2 waren: attitude ten opzichte van bewegingsgedrag, waargenomen voordelen van een actieve leefstijl (namelijk 'verbeterde gezondheid en een lagere kans op ziekten', 'een beter gevoel over jezelf' en 'grotere fitheid'), en één barrière voor bewegingsgedrag (namelijk 'beperkte omgevingsmogelijkheden'). Eigen effectiviteit, invloed van familie en vrienden, het waargenomen voordeel 'beter dagelijkse functioneren', en de barrières 'gezondheidsproblemen' en 'energiegebrek' bleken mediators te zijn op slechts één van de meetmomenten. Omgekeerde associaties werden gevonden voor de barrières 'gebrek aan geld', 'gebrek aan energie' en 'transportproblemen'.

Samenvattend: de combinatie van de R&S en AnR interventies verbeterde in de interventiegroep - vergeleken met de controlegroep - meerdere psychosociale determinanten en barrières voor bewegingsgedrag, negen weken en een jaar na het einde van de revalidatie. Deze verbeteringen hingen samen met de eerder besproken verbeteringen in bewegingsgedrag.

Discussie van de resultaten

In het laatste hoofdstuk wordt de conclusie getrokken dat dit proefschrift duidelijk heeft gemaakt dat een langdurige verbetering in bewegingsgedrag kan worden bereikt door bewegingsstimuleringsprogramma's te gebruiken die bestaan uit meerdere, op de persoon toegespitste counselingsessies tijdens en na de revalidatie, en die bovendien gericht zijn op persoonlijke en omgevingsfactoren. Onderzoek in de literatuur laat zien dat vergelijkbare bewegingsstimuleringsinterventies in andere settings en in andere populaties met een lichamelijke beperking of chronische ziekte ook effectief zijn om het bewegingsgedrag te verbeteren. Dit proefschrift geeft daarnaast een beter inzicht in de werkingsmechanismen van dergelijke interventies, in de onderliggende theorie alsook in het meten van bewegingsgedrag.

Tot slot is er een aantal methodologische onderwerpen besproken en zijn er aanbevelingen gedaan voor toekomstig onderzoek, en voor de praktijk en het beleid daaromtrent.

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About the author

Hidde Pieter van der Ploeg was born on the 16th of July 1975 in Amsterdam, the Netherlands. He went to primary school at the Levensboom in Blaricum and to high school (Atheneum) at the openbare scholengemeenschap Huizermaat in Huizen. After high school he started studying Human Movement Science at the Vrije Universiteit in Amsterdam. He finished the Master of Science education in 1999, with a major in exercise physiology and minors in psychology, and theory & history of human movement sciences. During his studies he participated in exercise physiological research at the Norwegian University of Sport and Physical Education in Oslo (Norway), where he lived for seven months. After his studies he worked for half a year as an assistant teacher in exercise and training physiology at the faculty of Human Movement Science of the Vrije Universiteit. In 2000, he started working on this PhD thesis at the Department of Public and Occupational Health of the VU University Medical Center in Amsterdam. During the first two years of his PhD he also worked part time at the same department as research assistant on the Amsterdam Graded Activity Study. He finished a postgraduate epidemiological education program during his PhD, at the Institute for Research in Extramural Medicine of the VU University Medical Center. Since July 2005 he is working as a research fellow on physical activity and health projects at the Centre for Physical Activity and Health at the University of Sydney in Australia.