Physical activity and physical fitness in children with chronic conditions

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CHAPTER 1

Introduction
Physical activity (PA), defined as ‘any bodily movement produced by skeletal muscles that requires energy expenditure’\textsuperscript{1}, has health benefits as it reduces the risk of cardiovascular diseases, stroke and diabetes. PA also contributes to prevention of risk factors like hypertension, overweight and obesity in adults\textsuperscript{2}. In children PA lowers the risk of depressive symptoms\textsuperscript{2}, reduces body mass index (BMI) and fat mass in children with overweight and obesity\textsuperscript{3}. Therefore global recommendations for PA were made by the World Health Organization (WHO) for adults as well as for children\textsuperscript{4}. The Committee for the Dutch Physical Activity Guideline advises children (age 4-18 years) to engage in moderate to high-intensity PA for at least one hour every day\textsuperscript{2,5}. With this advice the Committee for the Dutch Physical Activity Guidelines follows the international advise of the WHO.

In 2017 the Committee added to this advice; ‘PA is good for you - the more the better, the longer you are physically active, and the more frequent and/or more vigorous the activity, the more your health will benefit’. ‘Do activities that strengthen your muscles and bones at least three times a week and avoid spending long periods sitting down’ (sedentary behaviour)\textsuperscript{1}.

Despite these recommendations on PA for health, only 40% of the Dutch children engage in PA at moderate to vigorous intensity of one hour every day and in muscle and bone-strengthening activities at least three days a week\textsuperscript{6}. On average Dutch children spent between the 4.1 and 5.9 hours a day on sedentary behaviour\textsuperscript{6}. Sedentary behaviour is defined as ‘any waking behaviour characterized by an energy expenditure ≤ 1.5 metabolic equivalents, while in a sitting, reclining or lying posture’\textsuperscript{7}. So despite health benefits of PA Dutch children do not reach the recommendations on PA for health.

These PA guidelines are for children in general, but children with a chronic disease like juvenile idiopathic arthritis (JIA), juvenile dermatomyositis or a history of liver transplantation are less physical active compared to controls\textsuperscript{8–11} as has been attributed to parental overprotection, medication, fear of being too active, social isolation and ignorance of the health benefits of PA\textsuperscript{12}. For example in the past children with JIA were given restrictions on PA as it was assumed that PA could damage joints. Activity is more encouraged by physicians and physical therapists in these children in the last decade\textsuperscript{13} but in clinical practice it is still seen that children, parents and some caregivers are still cautious.
Introduction

In some chronic diseases, such as JIA and liver transplantation motor development is delayed\textsuperscript{14,15}, which might influence PA of the child. Children with less motor abilities might be less physically active, but on the other hand motor abilities develop through PA. It is known that better motor abilities are positively associated with PA and inversely associated with sedentary behaviour\textsuperscript{16}.

To determine PA different measurement can be used each with their advantages and disadvantages\textsuperscript{17,18}. Doubly labelled water method is the gold standard to objectively measure PA\textsuperscript{19} but is not suitable in clinical practice. Activity diaries and accelerometers are commonly used\textsuperscript{20}. In general activity diaries tend to overestimate PA\textsuperscript{21,22}, since not all activities are written down directly but by recall and in young children parents are writing down the activities, while they are not always around to objectively register the activities as during school time. Besides this, filling in an activity diary can be time consuming. On the other hand accelerometers are easy to use. Once the accelerometer is put on correctly, nothing needs to be done. Unfortunately accelerometers underestimate PA, because they do not record certain types of activity like cycling\textsuperscript{23}. So it is quite a challenge to measure PA objectively and on a child friendly manner.

In general it is assumed that children with a chronic disease will experience the same health benefits of PA as healthy children. Hence it is important to stimulate PA. Effects of such stimulating programs in children with a chronic disease are scantly available. It is evident that different factors contribute to the impact of increasing PA. For health benefits it is a challenge to find the right strategy on increasing PA especially in children with a chronic disease.

In addition to PA it is known that the aerobic fitness in children with a chronic disease is less compared with controls\textsuperscript{10,11,24–26}. Aerobic fitness is expressed as the maximal peak oxygen uptake (VO\textsubscript{2 peak}) and is a component of physical fitness. Physical fitness is defined as ‘a set of attributes that people have or achieve to perform PA’ and can be divided into health-related fitness like aerobic (or cardiorespiratory) fitness, muscular endurance and strength, body composition and flexibility and skill-related fitness, like agility, balance, coordination, speed, power and reaction time\textsuperscript{1}. Through exercise one can improve on physical fitness.
Chapter 1

The relationship between PA, health-related fitness and health is illustrated in Figure 1\textsuperscript{27}. The relationship between PA and health is complex, but it is assumed that by increasing PA, components of health-related fitness, such as body weight, muscle power, motor development, cardiorespiratory fitness and metabolic state can be influenced positively, resulting in increased quality of life, lowered morbidity and mortality. Physical activity can influence health-related fitness, but a higher health-related fitness level may increase the level of PA. Health-related fitness also influences health and health status also influences both health-related fitness and PA level. Health-related fitness is not only influenced by PA. Factors such as lifestyle behaviour, physical and social environmental conditions, personal attributes and genetic characteristics also affect PA, health-related fitness and health.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Figure1.png}
\caption{Associations between physical activity, health-related fitness and health (model according to Bouchard\textsuperscript{27}).}
\end{figure}
AIMS AND OUTLINE OF THIS THESIS

Children with liver failure have to acquire their motor abilities within different circumstances, like frequent hospitalization, surgery, less prone position, and medication as compared to healthy children. Data about motor development of children post liver transplantation is limited. Insight in motor development may help to develop interventions to improve motor abilities in these children as better motor abilities are positively associated with PA and inversely associated with sedentary behaviour.

The first aim of this thesis was to study motor development in young children pre transplantation and to determine if one year post liver transplantation motor development was similar to controls. In chapter 2 the motor development in children pre and post liver transplantation was determined and compared with norm values.

Current treatment of JIA improves with medication like biologic drugs and due to insights in pathogenesis. It can be assumed that the effect of better treatment of JIA and these medications has influence on the outcome of PA and the difference between healthy controls is reduced.

The second aim of this thesis was to analyse PA levels in children with JIA compared with controls. In chapter 3 PA in children with JIA were compared to controls regarding PA, sedentary behaviour and meeting PA guidelines. Besides this the effect of disease specific factors of JIA on PA were analysed.

Improved surgical techniques and use of medication with fewer side effects in children after liver transplantation have improved the survival in these children. It is assumed that better outcome also influences the outcome of PA. Physical activity at young age is important for growth and development. It is assumed that PA established during the young years may provide the greatest likelihood of health benefits at the long term. In general children are more active before puberty than after puberty. Therefore more insights in the PA levels of young children after liver transplantation in particular are needed. Knowledge about PA in young children is limited and sedentary behaviour is not always determined. Since only 40% of the Dutch children engage in activities as recommended in the activity guidelines, insight in children after liver transplantation meeting PA guidelines is also needed.
The third aim of this thesis was to get these insights in children after liver transplantation. In *chapter 4* PA and physical fitness in children after liver transplantation are compared with norm values.

The forth aim of this thesis (*chapter 5*) was to analyse, convergent validity of the two most common instruments used in clinical practise for measuring PA, the activity dairy and the accelerometer in children with JIA. Besides validity we analysed how many days in a week gave reliable results and the effects of combining both instruments for the correction of non-wear.

The final aim of this thesis was to determine the effects of intervention programs to stimulate PA. In *chapter 6* the effects of an exercise-training program in children and adolescents with juvenile dermatomyositis based on a randomized controlled trial are described. In *chapter 7* the effects of an internet program based on cognitive behavioural intervention to stimulate PA and aerobic fitness in children with JIA is described. *Chapter 8* is the general discussion.
REFERENCES


Introduction