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EXTENDED REPORT

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Objective: To obtain insight into the interaction between daily physical activity and components of health related physical fitness in children with juvenile idiopathic arthritis.

Methods: Forty five patients (10 male/35 female; mean (SD) age 8.9 (2.2) years) participated in the study. Body mass, height, skinfold thickness, number of swollen joints, and joint range of motion were determined. The maximal oxygen consumption (VO_{2peak}) was assessed during a graded maximal bicycle exercise test. Daily physical activity levels were measured with a Caltrac activity monitor and a parental physical activity rating (PAL) on a five point Likert scale.

Results: Partial correlation coefficients (to control for age) between physical activity and indices of health related physical fitness showed significant relationships between Caltrac motion counts and absolute VO_{2peak} ($r=0.31$) and relative VO_{2peak} ($r=0.34$), but not with the indices of body composition. There was also a significant correlation between PAL and relative VO_{2peak} ($r=0.33$).

Conclusions: Physical activity was significantly related to cardiorespiratory fitness but not to body composition in children with juvenile idiopathic arthritis. A longitudinal follow up should show whether an active lifestyle protects for loss of aerobic fitness in this patient group.

Health related physical fitness of a patient is dependent on both lifestyle related factors such as daily physical activity levels and nutritional habits, and genetic factors, and is an important indicator of health status. Health related physical fitness consists of different components, of which body composition and cardiorespiratory fitness (maximal oxygen uptake) are the most important.

Low physical fitness is associated with a higher mortality rate, a higher risk of certain forms of cancer, obesity, decreased mental health, diabetes, hypertension, and a lower quality of life.^{1,2} A recent study showed that every increase of maximal oxygen uptake reduces overall mortality in a clinical, adult population.³ For children and adolescents with a disability or chronic disease, physical fitness is no less important.⁴ Maintaining and improving physical fitness better prepares children and adolescents with a chronic disease for entering adulthood, providing a sound basis for their future health and preventing diseases induced by inactivity.² Children with juvenile idiopathic arthritis (JIA) have lower activity and participate significantly less in strenuous activities than their healthy peers.⁵

This may cause the reduced cardiorespiratory fitness in children with JIA.⁶ However, drugs and inflammation related factors may also contribute to this reduced exercise capacity. Reported data which might indicate whether there is a relation between physical activity and physical fitness in patients with JIA are lacking.

Therefore, the purpose of this study was to get more insight into the interaction between daily physical activity and components of health related physical fitness in children with JIA.

PATIENTS AND METHODS

Patients

Forty nine patients participated in the study. In four children the data on exercise testing were missing and therefore could not be included in the analysis. The data from 45 patients with JIA (10 male/35 female; mean (SD) age 8.9 (2.2) years) were diagnosed by a paediatric rheumatologist. The patients were

Table 1 Subject characteristics (n=45)

Characteristic	Min	Max	Mean	SD
Age of onset (years)	0.9	10	4.3	2.7
Height (m)	1.2	1.6	1.4	0.1
Weight (kg)	19	63	32.5	10.5
Number of swollen joints	0	8	1.6	2.1
EPROM score (0-3)	0	0.9	0.2	0.2
CHAQ (0-3)	0	2	0.8	0.6
Disease subclass	21 OJIA, 20 PJIA, 4 SJIA			

Min, minimum; Max, maximum; SD, standard deviation; CHAQ, Childhood Health Assessment Questionnaire; EPROM, Escola Paulista de Medicina Range of Motion Score; OJIA, oligoarticular juvenile idiopathic arthritis; PJIA, polyarticular juvenile idiopathic arthritis; SJIA, systemic juvenile idiopathic arthritis.

divided into three distinct types of JIA: oligoarticular JIA (arthritis present in four or fewer joints); polyarticular JIA (five or more joints affected with arthritis without systemic manifestations); systemic JIA (characterised by intermittent fever, rheumatoid rash, and arthritis). Table 1 presents the characteristics of the patients. All patients were receiving local and/or systemic arthritis related treatment consisting of non-steroidal anti-inflammatory drugs and/or disease modifying antirheumatic drugs and/or immunosuppressive drugs/steroids in the last six months before inclusion. All subjects were recruited from the paediatric rheumatology outpatient clinics of the Wilhelmina Children's Hospital, University Medical Centre Utrecht, the Netherlands and the University Hospital Groningen, the Netherlands. Parents gave their informed consent for participation in the study. All procedures were approved by the local medical ethical committees.

Abbreviations: CHAQ, Childhood Health Assessment Questionnaire; JIA, juvenile idiopathic arthritis; PAL, parental physical activity rating; VO_{2peak} , maximal oxygen consumption

Table 2 Clinical, physiological, and physical activity characteristics of the patients with JIA

	Min	Max	Mean	SD
BMI (kg/m ²)	14.1	25.2	17.3	2.8
BSA (m ²)	0.78	1.7	1.1	0.2
Σ7SF (mm)	41.2	246.7	98.2	47.2
V _{O₂peak} (l/min)	0.4	2.0	1.1	0.3
V _{O₂peak} (ml/kg/min)	14.6	50.4	33.9	8.5
Caltrac motion counts	19	138	84.9	23.3
PAL (1–5)	1	5	2.8	1.0

BMI, body mass index; BSA, body surface area; Σ7SF, sum of seven skinfolds; V_{O₂peak}, maximal oxygen uptake; PAL, parental rated physical activity level.

Anthropometry

The patient's body mass and height were determined with an electronic scale and a stadiometer. Body mass index was calculated as weight/height². Body surface area was calculated according to the formula of Haycock *et al.*⁷ Subcutaneous adiposity was assessed using the sum of seven skinfolds method according to Pollock *et al.*⁸ The measurements were taken at seven sites (at the right side of the body): triceps, biceps, subscapular, suprailiac, mid-abdominal, medial calf, and thigh by the test leader (TT) in accordance with the American College of Sports Medicine guidelines.⁹ The measurements were taken with Harpenden callipers (Baty International, Burgess Hill, Sussex, UK).

Joint range of motion

Joint range of motion was assessed with the paediatric Escola Paulista de Medicina Range of Motion Scale (EPMROM).¹⁰ Ten joint movements (cervical spine (rotation); shoulder (abduction); wrist (flexion and extension); thumb (flexion metacarpophalangeal); hip (internal and external rotation); knee (extension); and ankle (dorsiflexion and plantar flexion)) were examined with a goniometer and classified on a four point Likert scale (0 = no limitation to 3 = severe limitation). The final score was calculated as the sum of the mean joint score at each movement divided by 10, providing a final range of scores for joint movement (range 0–2).

Functional ability

The Dutch translation of the Childhood Health Assessment Questionnaire (CHAQ) was used as a self administered pencil and paper questionnaire for the parents (proxy), as an index of functional ability. The CHAQ¹¹ has been adapted from the Stanford Health Assessment Questionnaire, so that at least one question in each domain was relevant to children of 7 months to 19 years. The CHAQ has been recently cross culturally adapted and validated for the Dutch language by the PRINTO group.¹² The question with the highest score in each domain (range 0–3; 0 = able to do with no difficulty; 1 = able to do with some difficulty; 2 = able to do with much difficulty; 3 = unable to do; time frame was the past week) determined the score for that domain, unless aids or assistance were required (raising the score for that domain to a minimum of 2). The mean of the scores on the eight domains provided the CHAQ disability scale (range 0–3).

Aerobic physical fitness

The maximal oxygen uptake attained during a graded maximal exercise to volitional exhaustion is considered as the single best indicator of aerobic physical fitness by the WHO¹³ and is a reliable test in patients with JIA.⁶ Subjects performed a maximal exercise test using an electronically braked cycle ergometer (Lode Examiner, Lode BV, Groningen, the Netherlands). Five patients who did not fit on this ergometer were tested on a mechanically braked ergometer (Tunturi, Finland). The seat height of the ergometer was adjusted to the patient's

leg length. Three minutes of unloaded cycling preceded the application of resistance to the ergometer. Thereafter, the workload was increased by a constant increment of 20 W every three minutes. This protocol continued until the patient stopped of their own will because of exhaustion, despite strong verbal encouragement from the experimenters. During the maximal exercise test, subjects breathed through a face mask (Hans Rudolph Inc, USA) connected to a calibrated metabolic cart (Oxycon Champion, Jaeger, Mijnhart, Bunnik, The Netherlands). Absolute peak oxygen uptake was taken as the average value over the last 30 seconds during the maximal exercise test. Relative maximal oxygen consumption (V_{O₂peak}) was calculated as absolute V_{O₂peak} divided by body mass.

Physical activity

As index for the daily physical activity the children were asked to wear a Caltrac activity monitor (Muscle Dynamics Fitness Network, Inc, Torrance, Ca, USA) for four consecutive days (Friday, Saturday, Sunday, and Monday). The Caltrac is a portable electronic accelerometer about the size and weight of a pocket calculator that is placed on the right hip and measures movements in the vertical plane. The Caltrac sums and integrates the absolute value of the acceleration versus time curve and derives a numerical count that is displayed on the monitor. The Caltrac was programmed with the following variables to overrule the internal program (sex=0, age = 99, weight = 25, height = 36), in accordance with the recommendations of Sallis *et al.*¹⁴ In this mode, body movements were expressed as motion counts. The number on the display was recorded twice daily, in the morning after rising and in the evening at bedtime. Motion counts were recorded each day and then averaged for the four days worn. The Caltrac has been used and validated in various studies of healthy^{15,16} and diseased children, including those with juvenile arthritis.⁵

Additionally, parents were asked to rate their child's usual level of physical activity (PAL) on a five point scale: 1 = inactive, 2 = occasionally active, 3 = moderate active, 4 = active, 5 = very active, after Rowland and Boyajian.¹⁷ This is a simple, often used, method to provide an indication of the activity levels of the studied population, but it has not been validated.

Statistics

All data were entered and analysed in SPSS 10.0 for Windows. Pearson and Spearman correlations were calculated, where appropriate, for finding associations. Partial correlation coefficients between physical activity and indices of health related physical fitness were calculated to control for age. The coefficient of variation of the Caltrac was calculated as the standard deviation in counts over the four day period divided by the average of the Caltrac motion counts over the four day period. A priori, an α value of <0.05 was considered to be significant.

RESULTS

Table 2 shows the clinical, physiological, and physical activity characteristics of the patients with JIA. The wide range of subject characteristics shows the variation in physique of the patients and indicates an overall moderately impaired function. In four children the data for the exercise test were missing. On one occasion this was because the equipment failed, one patient was too sick to perform a maximal exercise test, and two patients refused to wear a face mask during the maximal exercise test, therefore no ventilatory parameters could be obtained.

The average day to day variation in Caltrac motion counts (coefficient of variation) was 32 (SD 15.4)%. The correlation between Caltrac motion counts and PAL was weak ($r=0.23$; $p=0.12$). Figure 1 shows that there was a significant inverse

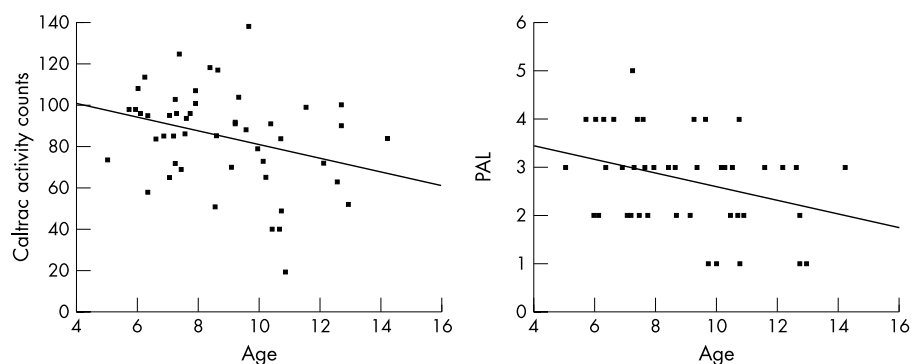


Figure 1 Relation between physical activity and age. The left panel depicts the relation between Caltrac activity counts and age. The right panel depicts the relation between PAL and age.

relation between Caltrac motion counts, PAL, and age ($r=-0.31$, $p = 0.03$; $r=-0.33$, $p = 0.023$ respectively). Therefore all correlations were controlled for age. It was also typical for the activity level of patients with JIA that only one patient in this sample had a PAL rating of 5 (very active).

Table 3 shows the relation between physical activity and health related physical fitness. When controlled for age, there was still a significant relation between physical activity and absolute and relative VO_{2peak} , but not with other anthropometrical variables, except for swollen joints and PAL.

DISCUSSION

The main objective of this study was to determine whether there exists a relation between physical activity and health related physical fitness in patients with JIA. To our knowledge, this is the first study studying this relationship in patients with JIA. A large variation in indicators of health related physical fitness was seen; this was also observed previously in a smaller sample of patients with JIA.⁶ Klepper *et al* found also a larger variation in physical fitness in patients with juvenile arthritis than in healthy children. This variation may be due to differences in environment, genetics, disease course, disease activity at time of the study, impairments, and concurrent drugs.

The current data of VO_{2peak} values of our subjects indicate that they have an impaired aerobic exercise capacity. The values we found for relative VO_{2peak} were lower than the typical values for healthy children. Rowland summarising published reports found typical values for VO_{2peak} in healthy children of between 45 and 60 ml/kg/min.¹⁸ The majority of VO_{2peak} values of our subjects were lower than these values. Results from a recent systematic review confirm this finding.¹⁹ This impairment in VO_{2peak} can have enormous effects on mortality in adult life. A recent publication showed that every increase of VO_{2peak} with 1 metabolic equivalent ($=3.5$ ml/kg/min) results in a 12% decrease in mortality.³ Improving physical fitness is a sound investment in future health.

The Caltrac motion counts are lower than the values found by Henderson *et al*.⁵ They measured on average 123 counts/day during a three day measuring period. Overruling

the internal program of the Caltrac may cause these differences. It is not clear from their methods if Henderson *et al*⁵ used the same settings for the activity monitor. Sallis *et al* using the same monitors and settings found an average Caltrac activity count of 103 counts/day,¹⁴ which is 22% higher than the 85 counts/day we found in this sample of patients with JIA.

Currently there is no "gold standard" for measuring physical activity. Many attempts have been made, including doubly labelled water, heart rate monitors, activity monitors, questionnaires, and, recently, global positioning system tracking devices. But all methods have their drawbacks of costs, practical usability, social acceptance, accuracy, etc.²⁰

In this study physical activity was assessed by a short questionnaire and a simple accelerometer. The large day to day variability in the Caltrac activity counts shows the difficulties in assessing the physical activity of patients with JIA. This high variability may well reflect the day to day variations in disease activity and wellbeing in patients with a rheumatic disease, a clinically well known feature in JIA. Recent research investigated how many days are necessary for a reliable assessment of physical activities in children, and concluded that a 3–5 day monitoring period including weekend days was sufficient.²¹ Maybe a longer period is necessary in patients with JIA because of this variability in disease activity and wellbeing.

The physical activity levels decreased with age. This trend is also seen in cross sectional²² and longitudinal studies in healthy children.²³ However, as patients with JIA already have lower VO_{2peak} values at early ages, they should be encouraged to increase physical activity, especially the older age groups. When physical fitness was correlated with physical activity we found an increase in physical fitness with increasing physical activity levels. It is difficult to determine which is the cause and which is the effect, because physical fitness and physical activity are circular arguments. A decrease in physical fitness causes a low physical activity, which again causes low physical fitness.²⁴

Our results indicated that body composition (weight, skinfolds, etc) has much lower associations with physical activity than physical fitness. Body composition is not only dependent

Table 3 Partial correlation coefficients (controlled for age) between physical activity and health related physical fitness characteristics

	Abs VO_{2peak}	Rel VO_{2peak}	BMI	BSA	$\Sigma 7SF$	Weight	Height	EPMROM	Swollen joints
Caltrac counts	0.3*	0.3*	-0.05	-0.2	-0.1	-0.2	-0.2	-0.1	-0.2
PAL	0.2	0.3*	0.2	-0.1	-0.05	0.2	-0.1	-0.2	-0.3*

Abs VO_{2peak} , Absolute VO_{2peak} (in l/min); Rel VO_{2peak} , relative VO_{2peak} (in ml/kg/min); BMI, body mass index; BSA, body surface area; $\Sigma 7SF$, sum of seven skinfolds; EPMROM, Escola Paulista de Medicina Range of Motion Score; PAL, parental rated physical activity level.

* $p < 0.05$.

on physical activity (energy expenditure) but also dependent on eating habits (energy intake). The difference between energy expenditure and energy intake, combined with an individual genetic make-up, determines body composition. Occasionally—endocrine change, due to prednisone treatment, for example—both aspects are involved. In our study group prednisone was given to three patients. The correlation between PAL and swollen joints indicated that the children with more severe disease (greater number of swollen joints) were less active.

Morrow and Freedson found, in a review paper, only small relationships between physical activity and $\text{Vo}_{2\text{peak}}$ in healthy children with a typical correlation of 0.16–0.17.²⁵ It has been suggested that healthy children have such a high level of physical activity that extra physical activity will only result in a small improvement in $\text{Vo}_{2\text{peak}}$ (ceiling effect).^{17, 26} Therefore, the relation between physical activity and $\text{Vo}_{2\text{peak}}$ in healthy children is only low to moderate. However, chronically ill patients have lower physical activity levels and will not have this ceiling effect. In this patient group the correlation between physical activity and $\text{Vo}_{2\text{peak}}$ is expected to be higher.

The correlation found in the current research is almost double that in healthy children; we found moderate correlation of 0.3 between physical activity and $\text{Vo}_{2\text{peak}}$ in sick children. This indicates that physical activity is important for improving physical fitness in children with a chronic disease, and emphasises the importance of creating opportunities for exercise in which patients with JIA can participate. Low physical fitness has a major impact on health, and quality of life.² It has been shown from studies that from the second decade of life the $\text{Vo}_{2\text{peak}}$ decreases by 0.41 ml/kg/min yearly,²⁷ suggesting that a lower physical fitness may result in early disability to perform activities of daily living in later life.^{2, 28}

In the past there was much concern about the safety of physical exercise for children with JIA. Historically, bed rest formed the cornerstone of treatment in rheumatic diseases, and at the end of the last century only mild graded exercise was allowed for these children. Vigorous exercise was believed to have detrimental effects on disease activity and joint erosiveness.²⁹ However, Klepper and Kirchheimer *et al* both found that children with JIA could safely participate in physical activities.^{30, 31} Moreover, Klepper showed that it is safe to involve children with JIA in vigorous weightbearing exercise.³⁰

Klepper performed an eight week intensive weightbearing exercise programme in 25 children with polyarticular arthritis and found no disease exacerbation or deterioration in joint swelling and tenderness score.³⁰ However, one must bear in mind that these patients do have a diminished loadbearing capacity because of their inflammatory disease and the immune suppressive drugs. Exercise training may improve immune function,³² but a training load which is too large may easily lead to overreaching or overtraining, as is often seen in athletes with a compromised immune system.³³ Medical specialists and healthcare professionals should, therefore, find a balance between training load and loadbearing capacity of each individual patient. This and future longitudinal studies in this field should provide the tools for individual tailoring of exercise programmes.

CONCLUSION

The data from this cross sectional study suggest that activity patterns of patients with JIA decrease between 5 and 14 years of age. Physical activity is significantly related to cardiorespiratory fitness but not to body composition. A longitudinal follow up should show whether an active lifestyle protects for loss of aerobic fitness in this patient group.

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ECHO

Intra-articular steroids can control JIA



Please visit the Annals of the Rheumatic Diseases website [www.annrheumdis.com] for link to these full articles.

Corticosteroid (CS) injection into affected joints is a safe and effective treatment for juvenile idiopathic arthritis (JIA), according to one review. Much of the supporting evidence comes from uncontrolled studies, but its sheer volume attests to the treatment's effectiveness.

The method is used most for oligoarticular and polyarticular JIA, with early injection in the oligoarticular form—without awaiting the outcome of NSAIDs treatment—to gain control and hasten return to normal activity. This avoids joint contractures and unequal leg lengths developing while also avoiding use of systemic CSs.

RCTs and clinical evidence have shown that triamcinolone hexacetonide is the best to use, so its present unavailability is regrettable. UK practice is to inject 1 mg/kg into large joints, 0.5 mg/kg into small joints, and 0.6–2 mg/joint into the hands and feet.

One RCT in children has suggested 246/300 triamcinolone hexacetonide injections produced complete resolution in a cohort including all JIA subtypes. In another study of nearly 1500 injections in almost 200 children median length of improvement with triamcinolone hexacetonide was 74 weeks. Best results occurred after the first injection.

The real value of the treatment is obscured in most published studies, because of confusion about JIA subtypes and differing definitions of improvement and length of follow up, not to mention a non-uniform approach to how the injection is given, the precise method, and the recovery schedule. Subcutaneous atrophy is the most well known side effect according to clinical experience. However, true assessment of outcome, CS joint versus systemic injection, or whether treatment modifies JIA await future RCTs.

▲ *Archives of Disease in Childhood* 2003;88:192–196.

. . .so can methotrexate

Methotrexate is invaluable for treating JIA, and its use should be continued, according to another review in the same series. The benefit that children derive outweighs the lack of evidence based RCTs, though these are needed to confirm long term effectiveness and safety.

There has been too little recognition of the transforming effect of methotrexate in one of the commonest chronic childhood disorders. In the UK, for example, it is not licensed for use in JIA. Elsewhere it is the first line treatment for polyarticular JIA, with or without steroids.

Just two short term RCTs have been done in children: one over a decade ago, showing significant clinical improvement in severe JIA, and the other more recently, confirming benefit for extended oligoarticular JIA. But a wealth of qualitative evidence exists from years of clinical use.

Modern treatment aims at securing early control of the disease and preventing joint damage, to maintain function and normal lifestyle. With standard treatment of weekly oral methotrexate 10–15 mg/m² 60–75% of recipients experience significant benefit after 4–6 months. Doses up to 20–25 mg/m² by injection can be used without apparent harm.

Monitoring treatment to ensure optimum benefit and safety is an issue for children, their parents, and their health carers; all need to be educated accordingly. Side effects seem to be low, but routine monitoring is required to detect altered liver function or blood profile or a rash, mouth ulcers, or breathing difficulties or cough. All signal a need to interrupt treatment until these are resolved.

▲ *Archives of Disease in Childhood* 2003;88:197–200.