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Original Research Article

Relationship between physical activity and functional ability in school-aged children with hemophilia

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ARTICLE INFO

Article history:
Received 8 February 2013
Accepted 8 July 2013
Available online 10 July 2013

Keywords:
Hemophilia
Physical activity
Functional ability
Joint health
Children

ABSTRACT

Introduction: With the advances in clotting factor replacement therapy children with hemophilia are increasingly encouraged to participate in physical activities and sports. Despite this positive trend, children with hemophilia still tend to be less physically fit than their healthy peers.
Aim: The main purpose of this study was to assess physical activity in school-aged children with hemophilia and its association with their functional ability, joint health and physical parameters.
Material and methods: Research material consisted of 24 boys aged 7–17 (mean 12.58±3.01 years) with severe or moderate hemophilia A or B. Weight, height and body mass index (BMI) were measured. Subjects activity level was assessed with Pediatric version of Hemophilia Activities List (PedHAL), joint health with Hemophilia Joint Health Score (HJHS version 2.1), functional ability with a Six-Minute Walk Test (6MWT).
Results and discussion: In Lithuanian children with hemophilia reduced physical activity (mean 83.64±11.40 scores) and functional ability (mean 408.46±68.58 m) were revealed. Strong negative correlation was found between PedHAL and HJHS scores ($r=-0.962$, $p<.0001$), HJHS and 6MWT ($r=-0.938$, $p<.0001$), strong correlation between PedHAL and 6MWT ($r=0.903$, $p<.0001$) scores. Distance walked displayed inverse correlation with age ($r=-0.858$, $p<.0001$), height ($r=-0.788$, $p<.0001$) and weight ($r=-0.894$, $p<.0001$).
Conclusions: Lithuanian children with hemophilia showed reduced physical activity and functional ability when compared with their healthy peers. The less joint impairments the subject had, the higher level of their physical activity and functional ability was. Age, height and weight were determinants of 6 minutes walking distance.

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http://dx.doi.org/10.1016/j.poamed.2013.07.004

1. Introduction

Motor fitness is considered an individual health measure. Its impact on human organism is extremely important during the early school years owing to the intensive growth at that time.[20] Although children are more agile than adults, they are at risk of consequences of hypokinesia due to the common forms of passive leisure activities.[19] Children with hemophilia are no exception to this notion. As a result of parental or medical restrictions, children with hemophilia often avoid any physical activity in their everyday life. Meanwhile, a physically active lifestyle is essential to maintain musculoskeletal health, reduce the risk of complications of hemophilia and ensure better quality of life in patients with this condition.[12,17,23,24] With the advances in clotting factor replacement therapy, children with hemophilia are increasingly encouraged to participate in physical activities and sports. In addition, it was noted that the attitude towards sports among patients with hemophilia has improved, and that the range of sports practiced has increased, presumably due to the improved medical treatment.[8,22] Despite this positive trend, children with hemophilia still tend to be less physically fit than their healthy peers. Koch et al. evaluated physical fitness of children with hemophilia aged 8.3–15.5 and reported a significant reduction in exercise capacity (peak work rate), possibly because of insufficient intensity of daily physical activities.[16] Engelbert et al. reported that children with hemophilia have a decreased aerobic capacity, lower reported leisure-time activity and less involvement in intense activity compared to their healthy peers.[5] Furthermore, Hassan et al. reported that children with hemophilia showed a decrease in distance achieved in the Six-Minute Walk Test (6MWT).[13] Muscle strength and anaerobic power were also significantly reduced in children with hemophilia, especially in the lower limbs.[14] In addition, children with hemophilia may be at increased risk of becoming overweight or obese as a result of inactivity because of joint bleedings or overprotection.[3] The need for a physically active lifestyle in patients with hemophilia is further highlighted by the finding that bone mineral density in children with severe hemophilia (FVIII/IX < 1%) is lower than in healthy subjects.[7]

2. Aim

The main purpose of this study was to assess physical activity in school-aged (7–17 years old) children with hemophilia and its association with functional ability, joint health and physical parameters.

3. Material and methods

This research was conducted in the Physical Medicine and Rehabilitation Center of Children's Hospital, Affiliate of Vilnius University Hospital Santariskiu Klinikos. Research material consisted of 24 boys aged 7–17 who suffered from severe or moderate hemophilia A or B. Weight and height were measured and a body mass index (BMI) was calculated (weight/height, kg/m^2).

Children's physical activity level was assessed using the Pediatric version of Hemophilia Activities List (PedHAL).[11] It contains 53 items across 7 domains and can be completed by both parents and children themselves. A raw score is converted to a normalized score that ranges from 0 (worst functional status) to 100 (best possible functional status).

Joint health of subjects was assessed with the use of the Hemophilia Joint Health Score (HJHS) version 2.1 by the International Prophylaxis Study Group (IPSG).[15] Joint function was measured with the HJHS, an eight-item scoring tool for the assessment of joint impairment of the six key index joints: knees, elbows and ankles. These eight items include duration of swelling, severity of swelling, muscle atrophy, crepitus on motion, flexion loss, extension loss, joint pain and muscle strength. Items are scored by grade of severity of impairment. The component joint scores were calculated, and an overall summarized score supplemented with a global gait score (i.e. observation of walking performance, stair climbing, running, and hopping on one leg). Thus, a final HJHS score ranges from 0 (no impairment) to 124 (maximum impairment for the six main joints).

Functional ability was determined by means of 6MWT.[1] It is a sub-maximal test of aerobic capacity, in which subjects walk as far as possible in 6 minutes around a pre-measured distance. It is a useful assessment tool for children with chronic conditions affecting the musculoskeletal system, because walking is a part of their everyday life.[13] In addition, heart rate was measured before and immediately after the 6MWT in a sitting position.

3.1. Statistics

Data analysis was performed using IBM SPSS Statistics 20.0 software. The results were analyzed and compared with the use of Student *t*-test and Pearson's correlation coefficient. Differences were considered statistically significant at $p < .05$.

4. Results

4.1. Subjects

Subject characteristics are presented in Table 1. Mean age of boys at the time of the study was 12.58 ± 3.01 years (range 7–17). A total number of children with severe hemophilia (FVIII/IX < 1%) was 21 and with mild hemophilia (FVIII/IX 6%–40%) – 3. Patients with severe hemophilia were treated prophylactically, whereas all patients with mild hemophilia received an 'on demand' treatment. All 24 subjects had joint impairments (mean 18.46 ± 7.28). In nearly half of the patients (45%) target joint was located at the ankle, in 33% at the knee, while the elbow was a target joint less frequently (21%).

4.2. Physical activity

All of the 24 PedHAL questionnaires were completed adequately and used for analysis. It took patients approximately 10 minutes to complete PedHAL questionnaire and there

Table 1 – Patient characteristics and test results ($n=24$).

Patient characteristics	Mean	SD	Minimum	Maximum	N (%)
Age, years	12.58	3.01	7.00	171.00	–
Height, m	1.58	0.14	1.24	1.76	–
Weight, kg	48.63	13.67	24.00	76.00	–
Body mass index, kg/m^2	19.18	3.39	13.77	27.92	–
Underweight	–	–	–	–	2 (8.3%)
Overweight	–	–	–	–	3 (12.5%)
Obese	–	–	–	–	0 (0%)
Hemophilia A, severe	–	–	–	–	21 (87.5%)
Hemophilia B, severe	–	–	–	–	3 (12.5%)
Target joints	2.40	1.30	–	–	–
Elbows	–	–	–	–	5 (20.8%)
Ankles	–	–	–	–	11 (45.8%)
Knees	–	–	–	–	8 (33.3%)
Test results					
HJHS	18.46	7.28	2.00	32.00	–
PedHAL	83.64	11.40	58.86	97.29	–
6MWD	408.46	68.58	302.00	516.00	–

Comments: PedHAL – Pediatric version of Hemophilia Activities List (0–124; best possible score is 0); HJHS – Hemophilia Joint Health Score (0–100; best possible score is 100); 6MWT – Six-Minute Walk Test (m).

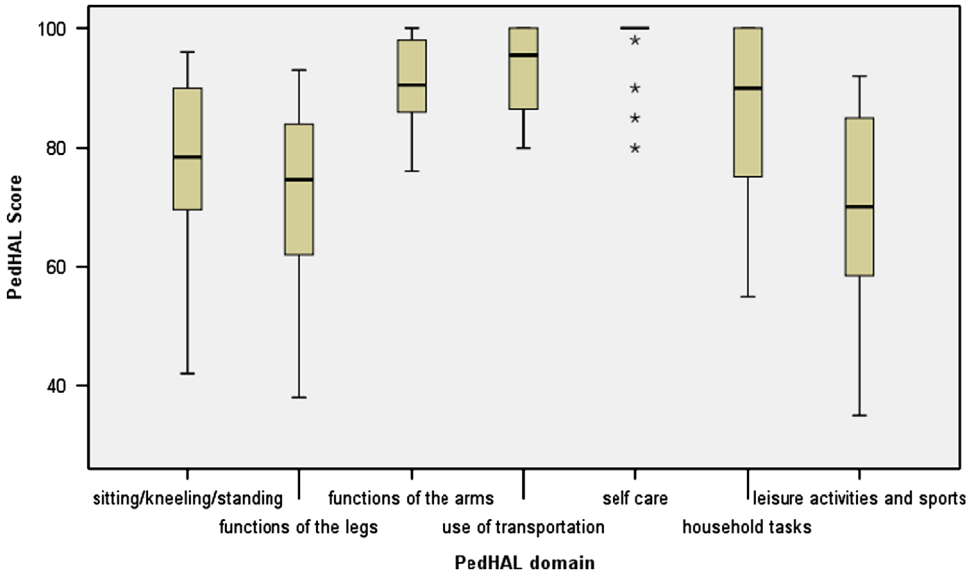

Fig. 1 – PedHAL domain scores and sum scores ($n=24$).

were no missing values in any of the PedHAL forms. The mean PedHAL score was 83.64±11.40 (range 58.86–97.29). The least difficulties were reported in the domains of self-care (mean 98.04±5.26, range 80–100), use of transportation (mean 93.08±7.49, range 80–100) and functions of the arms (mean 90.79±7.77, range 76–100) (Fig. 1). Performing various household activities (mean 86.71±14.04, range 55–100), sitting/kneeling/standing (mean 76.54±15.35, range 42–96) and functions of the legs (mean 71.58±15.67, range 38–93) were reported as more difficult. The highest proportion of activities that were stated as not applicable (N/A) were in the domain of leisure activities and sport (mean 68.71±16.96, range 35–92).

4.3. *Functional ability*

All children were able to complete 6MWT. Heart rate before the 6MWT was at an average of 87.50±11.59 bpm and after the 6MWT increased to a maximum of 120.13±12.09 bpm. Overall, the mean distance walked in 6 minutes was 408.46±68.58 m. The longest distance walked was in the group of the youngest subjects (7 years: 507.00±12.73 m) and the distance walked by children aged from 12 to 17 years decreased significantly with increasing age (12 years: 463.33±28.68 m; 13 years: 409.00±38.18 m; 14 years: 378.00±35.67 m; 15 years: 338.50±40.31 m; 17 years: 327.00±32.69 m; $p<.05$ between each group) (Fig. 2).

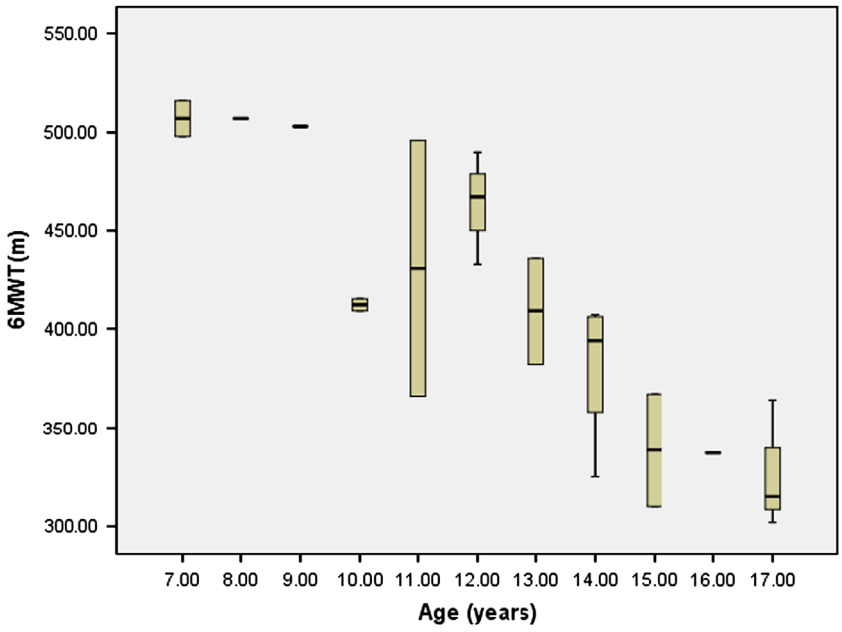

Fig. 2 – 6MWT scores in relation to subjects age.

4.4. *Relationship between PedHAL, HJHS and 6MWT*

A statistically significant negative (inverse) correlation was found between the PedHAL and HJHS scores ($r=-0.962$, $p<.0001$), HJHS and 6MWT scores ($r=-0.938$, $p<.0001$). Statistically significant correlation was also found between PedHAL and 6MWT ($r=0.903$, $p<.0001$) scores. When reducing joint damages in pediatric hemophilia, physical activity level and functional ability in this population increased.

4.5. *Relationship between 6MWD, age, height and weight*

Statistically significant negative correlations between 6MWD and age ($r=-0.858$, $p<.0001$), height ($r=-0.788$, $p<.0001$) and weight ($r=-0.894$, $p<.0001$) in children with hemophilia were observed (Figs. 3,4,5). Lower age, height and weight of the subject were associated with the greater 6 minutes distance achieved.

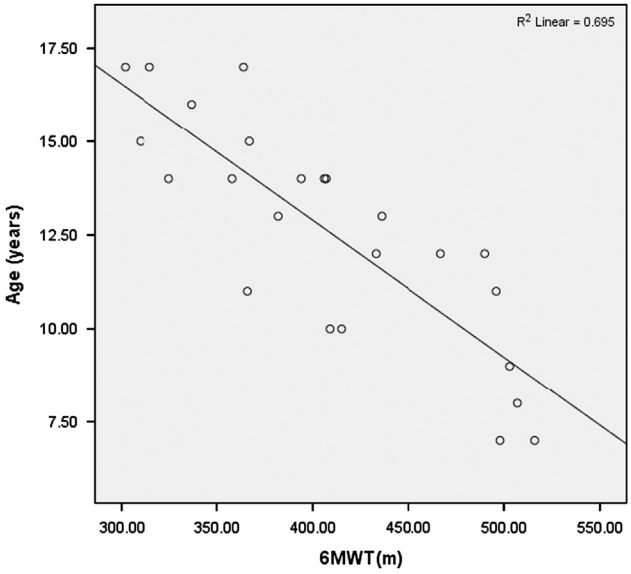

Fig. 3 – Correlation between 6MWT and age.

5. Discussion

The purpose of this study was to assess physical activity of school-aged children with hemophilia and its association with their functional ability, joint health and physical parameters. Results demonstrate that physical activity of Lithuanian children with hemophilia is still lower than in the population of regular prophylaxis. PedHAL domains and overall summary scores were considerably lower (83.64±11.40) than in Dutch children with the intensive replacement therapy (mean 97±7).[11] Despite their young age, Lithuanian patients recognized considerable limitations to their functional activities, including functions of the legs and participation in leisure activities and sport. Furthermore, the study investigated the progression of hemophilic arthropathy during childhood and puberty, with a particular emphasis on the age when significant changes occurred, based on the HJHS. In contrast, the majority of items in the domain "self-care" were scored as "never a problem." This indicates that several items in that domain are not problematic in this population and do not contribute to discrimination against patients.

Results of the 6MWT show that functional ability level of Lithuanian children with hemophilia is significantly reduced compared to healthy references. The mean 6 minutes distance was 408.46±68.58 m, while the mean walking distance of healthy peers was 470±59 m.[21] This is in accordance with previous observations of Hassan et al. who noticed that walking distances of children with hemophilia, juvenile idiopathic arthritis (JIA) and spina bifida (SB) are significantly reduced compared with their healthy peers. The hemophilia, JIA and SB patients achieved 90%–92%, 72%–75% and 60%–62% of the predicted walking distances, respectively.[13] These differences

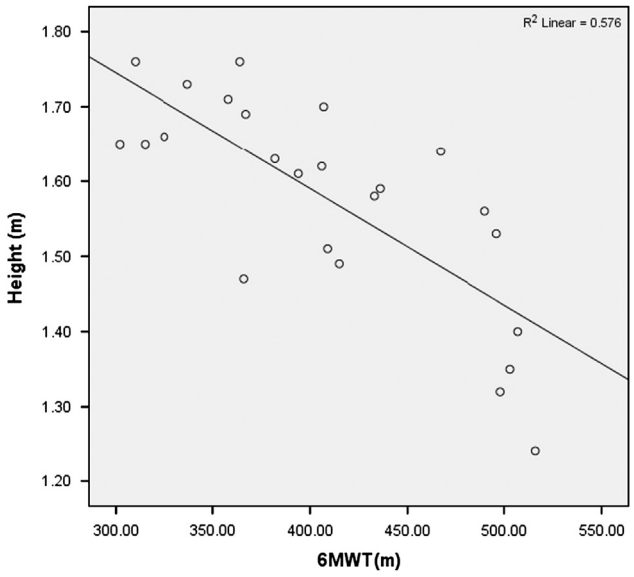

Fig. 4 – Correlation between 6MWT and height.

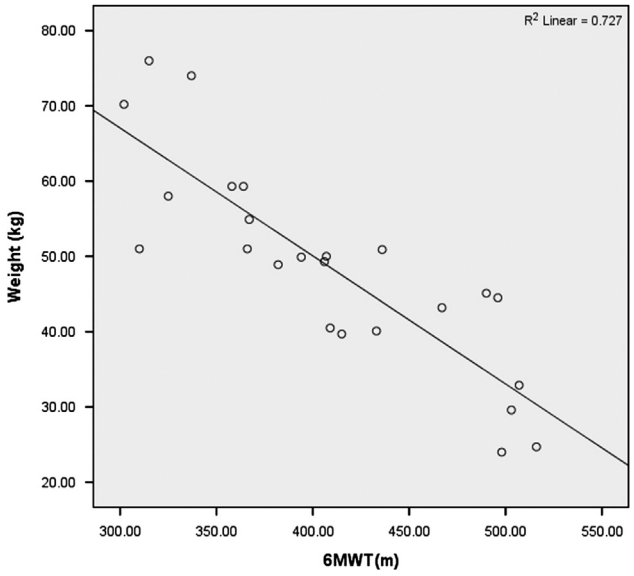

Fig. 5 – Correlation between 6MWT and weight.

could be explained by numerous data in the literature that suggest ankles being most frequently affected by hemarthroses, which have a negative influence on the performance of functional tasks requiring the activity of lower limbs. It is notable that even with such a small number of ankle hemarthroses in young children, key elements of the HJHS physical examination showed moderate or strong correlation with functional tests.[15]

As expected, we found strong association between PedHAL and HJHS summary scores ($r=-0.962$) which was similar to the previous findings in a Dutch sample (rho=0.59). The difference in the direction of the association between PedHAL and joint health in these two studies is caused by normalization of joint health scores in the Dutch sample which reverses the scoring.[9] Strong statistically significant correlation was also found between PedHAL and 6MWT ($r=0.903$, $p<.0001$) scores. This finding is inconsistent with the study of Groen et al., who did not find a significant correlation between PedHAL scores and 6MWT. These results are explained by the fact that 6MWT measures only one aspect of the patient's functional ability (i.e. walking ability). However, while monitoring heart rate during the 6MWT we observed the same trend as Groen et al. in Romanian children with hemophilia: the walking speed during the 6MWT has never reached an intensity that resulted in reaching a maximal cardio-respiratory response (only 54% of expected maximal heart rate).[10]

Previous studies showed that age, height and weight were determinants of the 6MWD in children.[4,18] In studies which involved healthy children and adolescents, the positive correlation between the 6MWD and age above 20 years result from the higher level of maturity of adolescents, when compared to children. On the other hand, shorter distance walked with increased age can be explained by decreases in muscle mass and strength and the maximum oxygen consumption, inherent to the aging process.[4] The consistent correlation between height and distance walked in the test can be attributed to the longer steps in taller individuals. Length of the step is one of the main determinants in gait velocity.[2] In case of relationship between the 6MWD and body weight, the authors observed that correlation had a linear characteristic only up to 30 kg. From this weight up, the correlation was horizontal. In elderly individuals, correlation was not linear either, with a point of inflection at approximately 82 kg, after which the 6MWD was under the negative influence of body weight.[6] However, in our study negative relationship between 6MWT and age ($r=-0.858$, $p<.0001$), height ($r=-0.788$, $p<.0001$) and weight ($r=-0.894$, $p<.0001$) could be explained by the fact that older children had more joint impairments that hindered longer distance performance. Thus, the lower the age, height and weight of the subject, the greater 6 min distance achieved.

6. Conclusions

1. Lithuanian children with hemophilia had reduced physical activity and functional ability due to joint impairments, when compared with their healthy peers.
2. The less impairment of joints the subjects had, the higher physical activity level and functional ability was.
3. Age, height and weight were determinants of the 6 minutes distance walked.

Conflict of interest

None declared.

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