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Original Article

The influence of hydrotherapy on obesity prevention in individuals with Duchenne Muscular Dystrophy.

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Abstract
Objective: To determine whether hydrotherapy is beneficial in terms of functional mobility in individuals with Duchenne muscular dystrophy evaluated by EK Functional Motor Scale, and its influence on BMI and percentage of fat mass. Methods: The sample contained seven individuals, male, six of which did not practice hydrotherapy and other individuals obtained hydrotherapy classes once or twice a week for 45 minutes. The EK scale was applied as well as non-parametric tests of Wilcoxon and Mann-Whitney. Results: The variables analysed were hydrotherapy, values of functional motor scale EK, BMI and percentage of body fat by testing the influence of these on the first. The results showed that as the BMI value increases, so is the percentage of fat mass higher, bringing major motor limitations to individuals, which means higher values on the EK scale. Conclusions: There were no statistically significant differences and there was a decreasing tendency of EK values in the individual with classes, compared to those who didn't practice, with these being higher. The values of correlation between the BMI and EK variables are considered "Fairly Good", though there were no statistically significant differences. When comparing the variables% MG and EK, there are values considered "very good", since the increase of one raises the other with a statistical significant value of 0.006.
Key-words: Functional Motor Scale EK; Duchenne Muscular Dystrophy; hydrotherapy; Percentage fat mass; BMI.

Introduction

Muscular dystrophies comprise a group of inherited diseases that are characterized by their nature of serious commitment, and progressive irreversible of the muscles. The Duchenne Muscular Dystrophy is the most common type among dystrophies that occurs in childhood by presenting their first symptoms between 3 and 4 years old. It evolves in a progressive way leading to muscular weakness, functional limitations, deformities; it reaches heart muscles and diminishes the respiratory vital capacity. This disease is characterized by the absence or deficiency of the production of the dystrophic protein of the muscle cell membrane, thus invalidating the normal functioning of the muscle. The presence of the scoliosis is frequent which constitutes an aggravating factor and subsequent thoracic deformities. Many can maintain independent walking up to 6 or 7 years old, but most will not live to adulthood, since they die due to chronic alveolar hypoventilation and/or aggressive chronic cardiomyopathy, Zitelli and Col (1992).

Its diagnosis is established in most cases by family history through clinical and genetic tests, being the muscle biopsy the most used. There is still no effective therapy to block or reverse the process of this dystrophy. However, there are some options that may bring some "relief" in functional terms as in the case of hydrotherapy. This resource has been widely used due to the physical properties of water, which facilitate the articular mobilization of these individuals, promoting the muscle relaxation and the freedom of movement that provide joy and satisfaction, allowing the accomplishment of activities that are not possible out of the water. The hydrotherapy performed in heated pool (28º-30º) is used to maintain the range of motion, muscle strength and breathing capacity.

The actual intervention of hydrotherapy, aims to improve mobility, to reduce the incapacities, to prevent the complications and, above all, to avoid the muscular retraction. For certain objectives to be defined and attained, it is necessary to use skills for the therapeutical success to occur in the assessment of the severity of functional impairment in patients with DMD. In that context, the use of scales that measure the functional degree for activities of daily life have a decisive importance, Martinez e Col. (2006).

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We used the EK Functional Motor Scale to quantify a value, which translated into a more or less limited dexterity on the part of the individual who obtained the hydrotherapy sessions. The EK scale, Egen Klassifikation (from the Danish: "our own classification"), was developed in Denmark to determine the degree of functional impairment of patients with DMD, and has been used as a useful method in the discrimination of distinct levels of functional performance for activities of these individuals daily life. It consists of ten questions with a score 0-30, considering that the higher the value, the greater the functional limitation.

The most common symptoms are rapidly progressive muscular weakness, frequent falls, difficulty in some day-to-day skills, especially climbing stairs, fatigue states occurring more rapidly, loss of intellectual capacity (in approximately 30%), skeletal deformities (scoliosis) and muscle deformities. In DMD patients it is possible to detect the deficiency or absence of the dystrophy protein in the muscle cell membrane, that demonstrate evidence in the absent or greatly diminished of the skeletal muscles, Miranda et all (1988).

- The weakness of the extensor muscles of the hip becomes stronger, rising up from the floor becomes more difficult and requires the use of the hands to "raise the legs". The English neurologist William Gowers, when observing, in 1879, the way the affected children by DMD were raising, describes what today is known by the "Gowers signal" or Gower positive manoeuvre, Zitelli and Davis (1992). The Trendelenburg march or the "swaying" of the hip also arises at this time. The time a patient wanders varies widely, ending by being confined to a wheelchair at the age of 7.

In this sense, we aim to acquire knowledge about this pathology, determine types of exercises that can mean an improvement in the quality of life of these individuals, and characterise the same in respect to their limitations. According to Zanardil and Col. (2002) and Mok and Col. (2006), there is a tendency to the increase of obesity in these individuals, due to the difficulty in moving. In this context, we have proceeded to the assessment of the BMI and of the percentages of the fat mass, and how these influenced the degree of mobility in the daily activities of the individuals considered in our study, which can be perceived in the values presented in the functional motor EK scale. This scale assigns a value to each individual that quantifies his greater or lesser capacity for skills. The higher the value on the scale, the greater is its limited dexterity. The EK scale has proven to be a useful method in the discrimination of different levels of functional motor skill for daily activities in patients with DMD. Hydrotherapy is thus used as a treatment option for muscular dystrophies, but always as a complement form, which, considering the physical proprieties of water, facilitates the muscle stretching exercises and articular mobilization, performed with pain relief. The main goal of this activity is to maintain the muscular strength, the respiratory capacity, the articular amplitudes and to avoid the limitation of the muscular extensibility. It also promotes the psychological well-being, because it turns out to be the only place where children, by the absence of gravity, can move in some way, which provides plenty satisfaction, Ovando (2008).

Caromano and Col (1998) used hydrotherapy in children with DMD between 8 and 15 years old. The exercises, conducted over eighteen sessions, promoted cardiorespiratory capacity. There was a normalisation of heart rate explained by hydrostatic pressure on the rib cage and abdomen and also by the effort performed inside water. It was observed that hydrotherapy provides small changes in relation to cardio-respiratory capacity, showing that despite not having changes in musculoskeletal terms, that does not represent an overload for children with Duchenne Muscular Dystrophy.

Methods

Selection of the sample

Our sample was constituted by seven individuals, all male. Their ages ranged between 9 and 11 years old. Six individuals did not practice any kind of physical activity, and the other individual got hydrotherapy classes once to twice per week in periods of 45 minutes. We applied the functional motor EK scale to quantify the degree of limitation of the individuals. The scale varies between 0 and 30 points, which means that the higher the value, the greater the dexterity limitation will be. All individuals were object of five evaluations, regarding the BMI, the percentage of fat mass and the value of the EK scale.

We evaluated the height and weight of each individual to the application of those in the BMI formula, calculated by the ratio height / weight ².

To evaluate the percentage of fat mass we resorted to anthropometric techniques by measuring the skinfolds, Vieira e Fragoso (2005). To the truly effect we used a meter of the fat skinfolds also known as adipometer, a digital readout plastic instrument that provides a better admeasurements. We respected the protocol procedures in the skinfolds measures: 1) Identify landmarks; 2) Mark the point to measure; 3) Highlight or emphasize the PA; 4) Measure the PA; 5) Perform the reading; 6) Remove the adipometer; 7) Release the PA.

After measuring folds, a technique also used by Mok and Col. (2006), we calculated the percentages of fat mass obeying to the so-called protocols of body composition, which are used according to the evaluated population. This protocol is used in children and adolescents aged 6 to 17 years of age with different values for Caucasians and black, as it can be seen in the following table. The formula used in this protocol, to the calculation of the fat mass percentage, only measures 2 (two) fat skinfolds, the tricipital and the subscapular skinfold. The equation to determine the same, in Caucasian and black children is the following:

$\%G = 1{,}35\ (TR + SB) - 0{,}012\ (TR + SB)^2 - C$ (C = constant, see table 1).

Table 1 – Values of the constants for age, sex and race from Lohman (1986), Pires and Petroski (1996).

Sex/Race	Ages											
	6	7	8	9	10	11	12	13	14	15	16	17
Masculine												
Caucasian	3,1	3,4	3,7	4,1	4,4	4,7	5,0	5,4	5,7	6,1	6,4	6,7
Black	3,7	4,0	4,3	4,7	5,0	5,3	5,6	6,0	6,3	6,7	7,0	7,3
Feminine												
Caucasian	1,2	1,4	1,7	2,0	2,4	2,7	3,0	3,4	3,6	3,8	4,0	4,4
Black	1,4	1,7	2,0	2,3	2,6	3,0	3,3	3,6	3,9	4,1	4,4	4,7

Proceedings *(EK Scale)* (see attachment 1).

The EK scale was also an evaluation instrument, because through it we quantified the degree of functional impairment of each individual. The EK scale is divided in 10 categories, each presenting 4 alternatives classified from 0 to 3. The result is obtained by the sum of the partials of each category that varies between 0 and 30. The higher the degree of the functional limitation, the higher the total score is, composed by a group of short sentences, easy to use and clarify.

Statistical Analysis The collected values from the evaluations were exported to computer applications. The statistical analysis of the data was performed by the program SPSS 17 (Statistical Program for Social Sciences), with a significance level of 0,05, using non-parametric tests of Kruskal-Wallis and U test of Mann-Whitney. The descriptive analysis (means and standard deviations) was calculated for all variables, in all assessments. Rho Spearman Tests were also carried out, checking the type of correlation between variables, and examining the statistical relevance.

Table 2 – Values obtained from the five evaluations made to individuals after applying the scale EK. (*individuals with no physical activity; ** individual with physical activity).

Individual	Evaluation	Age	BMI	% FM	EK
1*	1	7	15.34	16.09	3
	2	7	16,13	16,40	5
	3	8	16.91	16.72	6
	4	8	17,17	17,31	8
	5	9	17.43	17.91	10
2*	1	7	17.09	18.89	3
	2	7	18,33	19,48	6
	3	8	19.56	20.8	8
	4	8	19,94	21.04	10
	5	9	20.32	22	12
3*	1	6	20.20	17.68	2
	2	6	19,85	18,49	3
	3	7	19.51	19.30	4
	4	7	19,75	20,08	6
	5	8	20	22.3	7
4*	1	8	17.30	18.5	9
	2	8	17,54	18,95	10
	3	9	17.78	19.4	11
	4	9	18.45	23.3	14
	5	10	18.76	25.1	17
5*	1	9	18.61	20.22	9
	2	10	18,95	21,51	12
	3	10	19,65	24,10	15
	4	11	20	25.4	18
	5	11	21.8	27.4	21
6*	1	9	20.05	21.93	8
	2	10	20,54	22,26	11
	3	10	21.04	22.6	14
	4	11	21,39	23,43	16
	5	11	21.75	24.8	20
7**	1	9	31.37	23.11	9
	2	10	31.9	23.92	11
	3	10	30.76	24.86	13
	4	11	29.7	25.59	15
	5	11	29.3	27.33	18

The values between the practicing and non-practicing groups were also compared, as well as all the values obtained from the first to the fifth evaluation in all individuals, to verify what kind of influence hydrotherapy would have in the EK, IMC and % MG scale values. Table 2 shows us that all individuals increase the BMI values, percentages of fat mass and EK scale from the first to the fifth review. Individuals 1, 2, 3 and 4 present at the beginning of the evaluations fat percentages considered normal. For the BMI, all individuals have normal values (less than 24.9) according to ACSM (2001). At the end of the evaluations all individuals demonstrate percentages of fat mass considered high.

Table 3 – Values of the overall averages of the sample for the variables of BMI, fat mass and EK scale.

Group		BMI Mean	FM Mean	EK Mean
Evaluated Group	Mean	18,9547	20,5247	9,93333
	N	6	6	6
	Standard Deviation	1,51596	2,23905	4,56596

Table 3 presents the average values of the variables BMI,% FM and EK. The value of BMI is considered normal (ACSM, 2005), FM % is considered "Moderate High," Pires and Petroski (1996) and for the EK scale, the value is considered low, but is mitigated by younger individuals.

Procedures (Exercise Plan)

During the study a program of practical exercises was developed and implemented, to functional mobilisation of the individual in an aquatic environment in hydrotherapy sessions.

Table 4 – Comparison of mean values and standard deviation of the variable EK scale, from the first to the fifth assessment, between the physical activity/hydrotherapy practicing group and the non-practicing group.

Group		Av. EK 1	Av. EK 2	Av. EK 3	Av. EK 4	Av. EK 5
Non Practicing PA/H Group	Mean	8.5000	11,5000	14,5000	17,0000	20,5000
	N	2	2	2	2	2
	Standard Deviation	1,41421	2,12132	2,12132	2,12132	2,82843
Practicing PA/H Group	Mean	9,0000	11,0000	13,0000	15,0000	18,0000
	N	1	1	1	1	1
	Standard Deviation	.	.	.	.	.
Total	Mean	6,7143	8,8571	10,2857	12,4286	14,1429
	N	3	3	3	3	3
	Standard Deviation	4,34796	4,29839	4,42396	4,46681	4,91354

Results

In the following tables we will present the findings of the assessments resulting from individuals in the sample, for values of Age, BMI, percentage of fat mass and EK scale.
Tables 4 and 5 show us that the values of the EK scale increase from the first to the fifth evaluation of both groups, however they are lower in the group practicing physical activity / hydrotherapy.

Table 5 – Comparison of EK values between the groups, regarding the value of statistical significance and the final average

Group	Ev. EK 1	Ev. EK 2	Ev. EK 3	Ev. EK 4	Ev. EK 5	Final Average
Non Practicing Group Non Practicing AF/H	8.5	11.5	14.5	17	20.5	14.4
Practicing Group AF/H	9	11	13	15	18	13.2
Value of Significance	0, 129	0, 090	0, 105	0, 105	0, 097	0, 097

We verified that when comparing the two groups, both increase from the first to the fifth review. However, the group practicing physical activity / hydrotherapy shows lower values compared to the group that does not engage any type of physical activity, with minor differences between assessments.

We also verified that there are no statistically significant differences between groups. Nevertheless, the group practicing physical activity/hydrotherapy, besides presenting lower results on the EK scale, and although not being inferior to 0,05, have results relatively close to statistical significance as in the case of the evaluations two and five.

Table 5 also reveals the inexistence of statistical significant differences between the groups when compared to the overall average. It will be favourable to deduce that at the end of the five assessments the group practicing physical activity/hydrotherapy has greater ability in performing functional motor skills.

Table 6 – Values of correlation between the fat mass and EK scale.

Test	Average Mean and Coefficient		Mean EK	Mean FM
Rho Spearman's	Mean EK	Coefficient Correlation	1,000	0, 901
		Significance	.	0, 006
		N	6	6
	Mean MG	Coefficient Correlation	0, 901	1,000
		Significance	0, 006	.
		N	6	6

We verify that the factor of correlation between the average EK and the average of %FM is significantly higher (0,006). This value represents a quite positive and “Very Good” combination, once it is placed between 0,90 and 1. It is the second most influent factor in the values of EK scale. Obesity provokes a higher muscle abrade and enhances skeletal deformity. Our samples show distinct fat mass values knowing that a higher percentage of it interferes in major limitations in the EK scale. The high weight makes them more dependent, changing the their body composition, decreasing the amount of lean mass, which degenerates in conjunction with the progression of the disease. Nonetheless, the average percentages of our sample (20,52%) are inferior to the one of Zanardil and Col. (2002) which is found in 32% but superior to the one of Mok (2006) which is found in 10,4% with an average age of 10.

Table 7 - Values of correlation between age and EK scale.

Test	Average mean and Coefficient		Mean EK	Mean Age
Rho Spearman's	Mean EK	Coefficient Correlation	1,000	0, 982
		Significance	.	0, 000
		N	6	6
	Mean Age	Coefficient Correlation	0, 982	1,000
		Significance	0, 000	
		N	6	6

We verify that the factor of correlation between the average EK and the average of age is the highest (0,000). This value represents a very positive and “Very Good” association, once it is placed between 0,90 and 1. It is the most influent factor in the values of EK scale.

After an analysis of the tables, we verify that the variables of age and percentage of body fat are those that have the greatest influence on the EK scale, which corroborates the studies of Zanardil (2002) and Mok (2006). However, the age factor is not reversible, and as so, whenever people get older they will gradually increase their functional limitations. We verified this situation in Ramacciotti and Nascimento (2009) where the 6 year-old individual was not presenting significant limitations and still could walk and perform some tasks with support. On the other hand, the percentage of fat mass can be controlled and attenuated, with a balanced diet and very moderate physical exercise, taking into account the degree of limitation that each individual has.

Discussion

After all the analysis of the results we verified that there are no significant differences from one assessment to another. In any case, the physical activity implemented (hydrotherapy), although not arising improvement with significant values, did not present any harm. Physical activity/hydrotherapy brought benefits not only to the level of ADLs (Activities of Daily Living), but also in mobility, as it can be seen in Table 3, in

the fifth and final evaluation that include two years of study and where the biggest difference between EK scale values is revealed. We also verified that, regardless the values of BMI, fat mass and EK scale, age is the peremptory factor. As the age factor increases, the greater the motor limitation will be, namely, the EK scale value. We can see this data thorough table 6, where the correlation value is highly significant. Younger children are the ones who can perform some tasks by their own, and with very low EK values, Okama (2010).

Willing (1997) conducted a brief assessment of its 8 DMD patients, aged between 9 and 12 years old, and a mean value of 11.1 years old. The average value of the weight thereof was 34.5 kg, the average height of 1.41 m, the average BMI was 17.1 and the mean percentage of fat mass was 11.4%. This value indicates that the sample was not considered obese with a value much lower than in our study, with a higher average age. Corroborating with Okama's (2010) study, the dependency factor is higher in older individuals; also, such assessments create bases that allow some functional compensation that make possible the practice of some activities in an adapted form, and such changes need to be analysed to become less dependent.

Physical activity/hydrotherapy resulted in a positive and consistent approach to this type of population, and the physical environment in question becomes an environment with safe and efficient features, not representing in these cases, a burden on the individual; on the contrary, it ensures itself as the only place where they feel some joy Caromano et al. (1998), Caromano (2004). Physical activity/hydrotherapy can help in the treatment of these individuals, since the water can play a number of activities with pain relief and muscle relaxation, Ovando (2008) showing an enjoyable, challenging and motivating activity. Considering the study of Berard (2005), it was found that individuals who did not play any type of physical activity had an average EK scale value of 13.9, as well as in Okama (2010) where the mean EK range was 16, both above our case, which is at 13.2%.

We found that there are no significant differences from one evaluation to the next evaluation (table 3). In any way, the physical activity (hydrotherapy) implemented, was based on the criteria mentioned in the literature, and although it has not brought significant improvements, it brought no malware, and had an influence on the decrease in BMI and EK scale values, lower than the group without any type of physical activity, thereby showing complicity with Vitorino (2008), who showed that hydrotherapy brought advantages not only at the level of ADLs (Activities of Daily Living), but also in mobility, which is noticeable in Table 3, i.e., in the fifth and final evaluation which contemplates the two years of study and reveals the biggest difference between the values of EK scale.

When considering the functional capacity of these patients in their daily activity, we must take into account their dependency, because these factors change according to the progression of the disease and to the symptoms first identified. It seems justified an intervention to promote some kind of applicability as an assessment tool.

Among the various forms of assessment (muscular strength, range of movement, hydrotherapy, physiotherapy, scales, etc.) is important to use and adapt them as a means to delaying more severe complications, as the cardio-respiratory system ones. EK scale was chosen for containing objective and clear questions, and consequently, for providing important information of the daily activities of these individuals. It is found that the DMD patients see their motor skills progressively debilitated, leading to the use of the wheelchair and later to the aid of a fan. Thus, the use of rating scales, associated with other factors and methods, are always helpful and necessary to research tasks.

The EK scale has the benefit of being a test that can be applied at any stage of the disease, because of the fact that it is practical and non-invasive, not causing any pain or discomfort to the individual. In this sense, it is useful to intervene early in the child, attempting to mitigate the disease early and allowing quality of life, at least, more tranquilizing.

To sum up, we can prudently accept to say that physical activity / hydrotherapy in individuals with DMD provides positive influences towards an attenuation of motor limitations that interfere with their daily living activities, although there were no statistically significant differences between assessments; though not preventing, it slowed the limiting process of these individuals.

Conflicts of interest - the authors do not declare any conflict of interest.

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