Alqalam Journal of Medical and Applied Sciences. 2025;8(2):565-569
https://doi.org/10.54361/ajmas.258205

Original article

Comparing the Effect of Aquatic-Based Exercise *vs.* Land-Based Exercise on Functional Movement and Physical Performance in Down Syndrome Youth: Experimental Study

Ahlam AL Zayat*, Gaith Abdulbaset

Department of Physiotherapy, Faculty of Medical Technology, Tripoli University, Tripoli, Libya
Corresponding Email. *a.al_zayat@uot.edu.ly*

Abstract
Down syndrome, frequently abbreviated as DS, is a chromosomal disorder whereby a baby is born with an additional copy of chromosome 21. Down syndrome youth have been found to present with a limitation of balance, coordination, as well as the loss of gross motor and fine motor skills. This study aimed to establish the difference between the impact of aquatic-based exercises versus exercises performed on land on practical exercises involving functional movements and physical performance among Libyan young with Down Syndrome. The study involved 14 intellectually disabled individuals from two care centers in Tripoli, Libya. They were equally divided into 2 groups. All patients followed the physiotherapy program based on exercise and aquatic therapy for 1 hour, 3 times a week for 1 month. For the exercise intervention, the subjects were advised not to engage in the rest forms of exercise training. For all participants' functional fitness capacity, pre-tests were performed before the start of the intervention. The measures of functional fitness capacity were: body composition, weight and height, gait speed test, 10-meter walk test, balance test, single leg stance - eye opened/closed, muscle endurance of the upper body muscles, 1-minute push-ups, physical performance, and aerobic capacity; 100-meter timed test. All received data were processed statistically with Microsoft Excel (2020); p-values of various tests were used to determine the statistical significance (e.g., balance, coordination, lung capacity), to find out the differences in performance before and after the training. The level of significance was set at 0.05. data showed that the aqua therapy provided good improvement on the muscles related to gait speed(P=0.00004), muscle endurance(P=0.004) and aerobic capacity(P=0.00000186), a significant difference was observed for single leg stance test with eye closed (P= 0.0001) eye opened (P= 0.0003) in Favor to Land based exercise group. The study concluded that Aquatic-based exercise has a clear effect on physical performance and functional movement in youth with Down syndrome.
Keywords. Down's Syndrome, Aquatic Therapy, Physical Fitness, Balance, Land-Based Exercise.

Introduction

Down syndrome frequently abbreviated as DS is a chromosomal disorder whereby a baby is born with an additional copy of chromosome 21. This extra copy alters how a brain and body are made [1]. To the present, there is limited information concerning how many times this has occurred in Libya. In 2023, Five southwest cities were examined and the total of children diagnosed with Down Syndrome was 60, only 35 of which were females while the rest 65% were male [2]. Down syndrome has clinical feature of varieties from facial feature to internal visceral abnormality. Some of these are having flat facial features, and a short neck; a laxer joint in a child; poor muscle tone, or a bulging tongue, combined with other cardiac and muscular defects that impair the ability of an individual to undertake daily life activities [3].

Previous studies reported developmental changes of Down Syndrome on balance, and an overall coordination as well as the loss of gross motor and fine motor skills were well described [1,4]. Down's syndrome youth have been found to presents with hypotonic and weak hip adductor and knee extensor muscles when compared to normal children. The hip, feet & shoulder action is not well articulated and invokes high stress on the ligaments (which are elongated and joints over time).

The upper and lower limbs are also smaller than the trunk length in Down's syndrome children and this is why the movements are subdued or limited in these category [5]. Therefore, for the reasons of enhanced motor skills and coordinated better life style Aquatic based exercises is one of the most vital intervention tools for a better and more independent life style, where the patients are treated using the properties of water. Water's thermal and hydrostatic values are utilized, with the aid of buoyancy [6].

Thus, the body burden is reduced and people can perform activity which they can barely do or do very painful on the usury platform. That on land exercises maybe require specific equipment; these exercises are conducted to build up the muscle groups, or to milestone flexibility in a joint or to work on the balance and coordination of the body. It is performed on the land instead countering the forces of gravity and the person's body weight and is highly different from water exercises for example Aquatic [3]. Both of them are used in the Down syndrome therapy since they are easy to perform and according the literature, they are considered to be less onerous and more motivating in compare with other kinds of rehabilitation [1,3].

A prior systematic review [1] showed hydrotherapy advantage over conventional land-based exercise in terms of muscle strength and body stability. To the study, the basic measurement device and the accurate

Received*: 03-01-2024 -* ***Accepted****: 05-03-2025 -* ***Published****: 09-04-2025*

functional assay, with which to set the initial inequality (pre and post), were missing; in addition, marginal consideration was given to human biology, for instance, BMI and oxygen use rates, et cetera. Another non randomized trial has somehow defined Aquatic therapy Vs exercises [3]. From this trial, it can be concluded that quantitative evidence prevents the recommendation of aquatic interventions for improving balance and upper body strength in adults with a primary purpose of functional fitness, for three adults at least. The primary aim of the study, therefore, was to establish the difference between the impact of aquatic-based exercises versus exercises performed on land on practical exercises involving functional movements and physical performance among the Libyan young with Down Syndrome

Methods

Participants

Concerning the participants' gender, there were 12 male and 2 female, and the study involved 14 intellectual disabled individuals from two care centers in Tripoli Libya. These criteria were eligible due to the following criteria; The participants must be 10 years old or above, Participants must have DS, The parent or legal guardian of the participant must sign informed consent before participating, All participants reported no difficulty with physical activity requiring musculoskeletal movement. Any patient who has severe mental retardation, physical disabilities, heart disease, respiratory disorder was excluded in the study. This research was done under the clearance of the Ethical Committee of the University with reference number (4670-18-12).

Study setting

This was an experimental study carried out on 7 participants each from each disabled center they were equally divided into 2 groups all patients followed the physiotherapy program based on exercise and aquatic therapy for 1 hour, 3 times a week for 1 month. For the purpose of the exercise intervention, the subjects were advised not to engage the rest forms of exercise training.

Testing

For all participants' functional fitness capacity pre-tests were performed before the start of the intervention. The measures of functional fitness capacity were; body composition; weight and height, gait speed test; 10-meter walk test, balance test; single leg stance -eye opened, closed, muscle endurance of the upper body muscles; 1minute push-ups, physical performance and aerobic capacity; 100-meter timed test. Functional performance was measured at baseline prior to the administration of the physiotherapy intervention (week 0) and then after administering the physiotherapy intervention one month later.

Data analysis

All received data were processed statistically with Microsoft Excel (2020); p-values of various tests were used to determine the statistical significance (e.g., balance, coordination, lung capacity). The data have been shown as mean differences and standard deviations of the difference. To find out the differences in performance before and after the training a paired t test was conducted. Level of significance was set at 0.05 and a conclusion was made where $p<0.05$.

Results

A total of 14 participants completed the study (12 men and 2 women); the aquatic group consisted of 7 males, while the land-based exercises consisted of 5 males and 2 females. Baseline characteristics data for both groups are presented in Table 1&2.

Table 1. Descriptive baseline characteristics data of Aquatic exercise group

Patient No.	Age (year)	Height (cm)	Weight (kg)	Body mass index (Kg/m2)
1	14	1.54	58	24.45
2	15	1.53	70	29.92
3	23	1.59	63	24.91
4	14	1.46	44	20.64
5	14	1.47	43	19.89
6	16	1.65	76	27.91
7	13	1.43	50	24.45
SD	(2.91)	(8.91)	(12.91)	(4.72)

From table 3-5, Three of the four functional movements measures; 10-meter walk test; single leg stance and 100-meter timed test were improved significantly on participants who underwent aqua therapy. Thus, it is noted that the aqua therapy provided good improvement on the muscles related to gait speed (P=0.00004), muscle endurance(P=0.004) and aerobic capacity(P=0.00000186).

Received*: 03-01-2024 -* ***Accepted****: 05-03-2025 -* ***Published****: 09-04-2025*

https://doi.org/10.54361/ajmas.258205

Table 2. Descriptive baseline characteristics of the Land-based exercise group

Patient No.	Age (year)	Height(cm)	Weight(kg)	Body mass index (Kg/m2)
1	26	1.57	71	28.80
2	19	1.65	46.5	17.08
3	15	1.63	71	26.72
4	15	1.52	63.4	27.44
5	13	1.45	43	20.45
6	15	1.64	73	27.14
7	15	1.42	54	26.78
SD	(2.79)	(8.54)	(12.38)	(4.53)

Table 3. Descriptive statistics for pre- and post-exercise results, * P<0.05

Patient No.	10 minutes' walk test			
	Aquatic exercise		Land-based exercise	
	Before	After	Before	After
1	20	18	20	22
2	22	19	35	32
3	35	30	0	0
4	35	31	30	28
5	24	22	17	21
6	21	19	20	17
7	23	21	22	25
p-value	0.00004*		0.0004*	
SD	(1.11)	(0.98)	(1.07)	(1.11)

Table 4. Descriptive statistics for pre- and post-exercise results, * P<0.05

Patient No.	1- minute push up test			
	Aquatic exercise		Land-based exercise	
	Before	After	Before	After
1	10	10	40	16
2	11	10	16	14
3	9	9	30	25
4	15	13	0	50
5	18	15	0	20
6	15	11	12	13
7	9	9	0	33
p-value	0.004*		0.39*	
SD	(2.69)	(2.94)	(2.76)	(2.91)

Table 5. Descriptive statistics for pre- and post-exercise results, * P<0.05

Patient No.	100-meter timed test			
	Aquatic exercise		Land-based exercise	
	Before	After	Before	after
1	176	170	47	44
2	126	120	50	46
3	170	165	73	66
4	198	189	62	58
5	198	192	56	53
6	185	179	55	51
7	190	184	60	57
p-value	0.00000186*		0.0000084*	
SD	(4.11)	(3.99)	(4.15)	(4.08)

Received*: 03-01-2024 -* ***Accepted****: 05-03-2025 -* ***Published****: 09-04-2025*

https://doi.org/10.54361/ajmas.258205

Compared to posttest results, table 6 A and B shows clearly a significant difference for single leg stance test with eye closed (P= 0.0001) and when eye opened (P= 0.0003) in Favor to Land based exercise group. Hence, it is noted that the land-based training provided good improvement on the muscles related to body balance.

Table 6A. Descriptive statistics for pre- and post-exercise results, * P<0.05

Patient No.	Single leg stance test (Eye closed)			
	Aquatic exercise		Land-based exercise	
	Before	After	Before	After
1	20	22	3	3
2	4	6	3	4
3	3	5	0	0
4	3	4	0	2
5	3	5	0	3
6	4	8	15	15
7	3	6	0	1
p-value	0.082*		0.0001*	
SD	(1.57)	(1.80)	(1.60)	(2.76)

Table 6B. Descriptive statistics for pre- and post-exercise results, * P<0.05

Patient No.	Single leg stance test (Eye opened)			
	Aquatic exercise		Land-based exercise	
	Before	After	Before	After
1	49	53	4	5
2	45	47	11	15
3	8	16	2	3
4	8	15	3	5
5	9	11	17	18
6	6	13	16	18
7	8	8	5	6
P-value	0.0013*		0.00003*	
SD	(2.69)	(2.99)	(2.76)	(3.30)

Discussion

The study was about Libyan youth with Down syndrome and aimed to examine the effects of an aquatic based intervention Vs. Land based exercise. It is well known that due to lack of required physical fitness, balance, speed and muscle endurance, Down Syndrome patients lose their ability to integrate in society [7] Therefore, the authors aimed to evaluate the functional fitness capacity of 14 DS divided in to 2 groups, each group had a rehabilitation program composed of a total of 10 aquatic-based exercise sessions/ land-based exercise for 1 month. In the present study our cohort of youth with Down syndrome showed improvement in all measures of functional fitness capacity, statistically significant improvements were shown for 10-meter walk test; single leg stance and 100-meter timed test.

Hydrotherapy can increase body's posture and motion thanks to its physical properties [8] conductivity, buoyancy, hydro-static pressure, and resistance [9]. Therefore, the authors suggested that concerning overall functional changes, participants with Down syndrome showed a greater ($p < .05$) improvement in all parameters than the land-based exercise.

For aerobic capacity they have also presented the statistical significance for gains reported on by the participants. These results are similar to another trail that showed the positive impact of Aqua therapy on the respiratory system of people with Down syndrome [10]. it means that the positive outcomes being obtained from the advantages of the aquatic environment on body circulatory and respiratory system [11]. Nevertheless, the 100-meter timed test employed in this experiment can hardly be regarded as fully reliable to measure lung capacity since this test is not regarded as standard for this measurement and thus may not have captured the differences between the assessments [10].

The result revealed a positive shift in the body balance while using aquatic-based exercises but to some extent not as it was portrayed in the land-based exercises. This might be because of a short duration, which was 3 times a week for one month which is considerably not enough to restore body equilibrium, other literatures showed a great balance restoration after applying aquatic therapy up to 12 weeks [12]. Last but not the least, focus of this study has demonstrated that youth get and stick to physiotherapy sessions more than easier weather was hydrotherapy or conventional training and could hence also serve to decrease mental illness, behavior disorders, apathy, and change in weight [13]. Therefore, positive findings were in the favor of both the parties.

Received: *03-01-2024* - ***Accepted***: *05-03-2025* - ***Published***: *09-04-2025*

A possible limitation of this study regarding small sample size, short duration of both treatment programs (1 month), in addition to exercise intensity and how it is related to aerobic performance which was not tested for both groups. For the future clinical implications, the authors propose hydrotherapy as one of the complementary therapies that should form part of the weekly schedule alongside the other therapies they attend. As for future research implications, the authors recommend to investigate the physical properties of Aquatic therapy as the thermal effect on exercise performance for Down syndrome patients, addition to postural responses in young children with Down's syndrome compared to adults.

Conclusion

There is potential to enhance or at least maintain the youth with Down syndrome potential in enhancing over all physical performance or functional movement based on the water group with aquatic-based exercise in a comparison with land-based exercise program.

Conflict of interest. Nil

References

1. Priya C. Comparative study on aquatic therapy vs. exercise for toddlers with trisomy 21 (Down's syndrome). 2019.
2. Abugrara Matuk A, Alkelany Abdelsalam A. Fezzan University Scientific Journal. Vol. 2. Fezzan University; [cited 2019].
3. Boer P, de Beer Z. The effect of aquatic exercises on the physical and functional fitness of adults with Down syndrome: a non-randomised controlled trial. J Intellect Disabil Res. 2019 Dec 29;63(12):1453–63.
4. Lewis CL, Fragala-Pinkham MA. Effects of aerobic conditioning and strength training on a child with Down syndrome: a case study. Pediatr Phys Ther. 2005 Mar;17(1):30–6.
5. What do we know about the movement abilities of children with Down syndrome? Down Syndrome News and Update. 2003;2(4).
6. The influence of physiotherapy on functional fitness of adults with Down syndrome. Discobolul – Phys Educ Sport Kinetother J. 2019;55(1):55–62.
7. Muñoz-Llerena A, Ladrón-de-Guevara L, Medina-Rebollo D, Alcaraz-Rodríguez V. Impact of physical activity on autonomy and quality of life in individuals with Down syndrome: a systematic review. Healthcare (Basel). 2024;12(1):[Epub ahead of print].
8. Memolo J. Mechanical agents/hydrotherapy. In: Therapeutic agents for the physical therapist assistant. Huntsville (AL): Taylor & Francis; 2024. p. 59–73.
9. Kopack J, Cascardi K. Principles of therapeutic exercise for the physical therapist assistant. New York: Routledge; 2024.
10. Handolias K, Konstantinidou E, Bikis E, Hourlia A, Besios T, Tsigaras G. The effectiveness of 6 months hydrotherapy program based on Halliwick concept on the respiratory system of Down syndrome children. J Biosci Med (Irvine). 2021;9(3):20–6.
11. Hamed SA. Effect of aquatic program therapy on dynamic balance in Down's syndrome children. J Med Sci Clin Res. 2016 Mar 30;4(3):[about 6 p.]
12. Viana FP. Effects of hydrotherapy in balance and prevention of falls among elderly women. Braz J Phys Ther. 2008;12(1):57–63. Barnhart RC, Connolly B. Aging and Down syndrome: implications for physical therapy. Phys Ther. 2007 Oct;87(10):1399–406.

المستخلص

متلازمة داون هي اضطراب كروموسومي يولد فيه الطفل بنسخة إضافية من الكروموسوم 21. وقد وجد أن الشباب المصابين بمتلازمة داون يعانون من قيود في التوازن والتنسيق بالإضافة إلى فقدان المهارات الحركية الإجمالية والمهارات الحركية الدقيقة. وكان الهدف من هذه الدراسة هو تحديد الفرق بين تأثير التمارين المائية مقابل التمارين التي يتم إجراؤها على الأرض على التمارين العملية التي تنطوي على حركات وظيفية وأداء بدني بين الشباب الليبيين المصابين بمتلازمة داون. شملت الدراسة 14 فردًا من ذوي الإعاقة الفكرية من مركزين للرعاية في طرابلس ليبيا. تم تقسيمهم بالتساوي إلى مجموعتين. اتبع جميع المرضى برنامج العلاج الطبيعي القائم على التمارين والعلاج المائي لمدة ساعة واحدة، 3 مرات في الأسبوع لمدة شهر. لغرض تدخل التمارين، نُصح الأشخاص بعدم الانخراط في أشكال الراحة من تدريب التمارين. تم إجراء اختبارات مسبقة لقدرة اللياقة البدنية الوظيفية لجميع المشاركين قبل بدء التدخل. كانت مقاييس قدرة اللياقة البدنية الوظيفية هي؛ تكوين الجسم؛ الوزن والطول، اختبار سرعة المشي؛ اختبار المشي لمسافة 10 أمتار، اختبار التوازن؛ وضعية الساق الواحدة - العين مفتوحة / مغلقة، قدرة التحمل العضلية لعضلات الجزء العلوي من الجسم؛ تمرين الضغط لمدة دقيقة واحدة، الأداء البدني والقدرة الهوائية؛ اختبار 100 متر محدد الوقت. تمت معالجة جميع البيانات المستلمة إحصائيًا باستخدام(2020) Microsoft Excel ؛ تم استخدام القيم الاحتمالية للاختبارات المختلفة لتحديد الأهمية الإحصائية (على سبيل المثال، التوازن والتنسيق وسعة الرئة)، لمعرفة الاختلافات في الأداء قبل التدريب وبعده. تم ضبط مستوى الأهمية عند 0.05. أظهرت البيانات أن العلاج المائي قدم تحسنًا جيدًا في العضلات المتعلقة بسرعة المشي (P = 0.00004)وتحمل العضلات (P = 0.004) والقدرة الهوائية(P = 0.00000186) ، لوحظ فرق كبير في اختبار وضعية الساق الواحدة مع إغلاق العين (P = 0.0001) وفتح العين (P = 0.0003) لصالح مجموعة التمارين القائمة على الأرض. وخلصت الدراسة إلى أن التمارين الرياضية المائية لها تأثير واضح على الأداء البدني والحركة الوظيفية لدى الشباب المصابين بمتلازمة داون.

Received: *03-01-2024* - ***Accepted***: *05-03-2025* - ***Published***: *09-04-2025*