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The Impact of an Aquatic Activities Programme on Emotional and Behavioral Difficulties in Young People with Down Syndrome

Silviu PETRESCU [1]
Cătălin PĂUNESCU [2*]
Oana PETRESCU [3]
Teodor PĂUNESCU [4]
Gabriel PIȚIGOI [5]

[1]Associate Professor PhD, University of Medicine and Pharmacy "Carol Davila", Bucharest, Romania; https://orcid.org/0009-0004-4994-0738; silviu.petrescu@umfcd.ro
[2] Professor PhD, University of Medicine and Pharmacy "Carol Davila", Bucharest, Romania; https://orcid.org/0009-0004-8947-9077; Catalin.paunescu@umfcd.ro
[3] Associate Professor PhD, University of Medicine and Pharmacy "Carol Davila", Bucharest, Romania; https://orcid.org/0009-0008-9005-5545; oana.petrescu@umfcd.ro
[4] Student Faculty of Physiotherapy, National University of Physical Education and Sport, Bucharest, Romania; https://orcid.org/0009-0002-0708-2611; paunescuteodor2003@gmail.com
[5] Professor PhD, University of Medicine and Pharmacy "Carol Davila", Bucharest, Romania; https://orcid.org/0009-0000-2919-5970; gabriel@umfcd.ro
[*] *corresponding author:* catalin.paunescu@umfcd.ro

Abstract: *Down syndrome, a genetic disorder associated with delays in intellectual and physical development, is frequently associated with emotional and behavioral difficulties, and recreational therapeutic interventions, such as aquatic activities, have been associated with improvements in both physical condition and mental wellbeing of the participants.*
This study investigates the effects of an aquatic-based intervention on the psychosocial status of adolescents diagnosed with Down syndrome, using the Strengths and Difficulties Questionnaire as an assessment tool (SDQ). This research activity took place in the swimming pool of the University of Medicine and Pharmacy "Carol Davila". Aim: The study aimed to statistically highlight the potential of aquatic activities as a complementary form of therapeutic intervention on the emotional state, behavior and development of prosocial behavior in young people with Down syndrome. Methods: The research included 34 participants with an average age of 16.06±1.09 years, involved in a structured program of aquatic activities carried out over 6 months, with two sessions per week. Results: These indicate significant reductions in emotional symptoms and conduct problems, along with a significant increase in prosocial behavior. The potential of aquatic activities as an effective psychosocial intervention strategy for adolescents diagnosed with Down syndrome is emphasized. The results of the research highlight the potential of aquatic activities as a complementary therapeutic tool in promoting psychosocial well-being in adolescents with intellectual disabilities.

Keywords: *aquatic activities; down syndrome; swimming; complementary therapy.*

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Introduction

Down syndrome (DS) is a chromosomal condition resulting from the presence of an extra copy of chromosome 21, which significantly affects the cognitive, physical and behavioral development of individuals (Antonarakis et al., 2020). Individuals diagnosed with DS often exhibit significant delays in motor development and difficulties in performing functional motor tasks, an aspect consistently highlighted in the literature (Matson et al., 2010). Also, the high prevalence of congenital heart malformations among people with Down syndrome is a major contributor to morbidity and mortality, particularly in regions where access to corrective surgery is limited or non-existent (Benhaourech et al., 2016). Thus, these individuals also show a reduced level of general physical fitness, evidenced by significantly lower muscle strength values (Melo et al., 2022) and aerobic capacity (Oviedo et al., 2022) compared to the adult population without Down syndrome. In addition to specific physical limitations, these people with DS frequently show emotional difficulties, behavioral disorders and deficits in social skills, significantly affecting their integration and adaptation in educational and community environments (Pikora et al., 2014).

Swimming, widely acknowledged as a beneficial mode of physical activity, provides individuals with intellectual disabilities an accessible and low-impact environment that supports the development of motor coordination, improves physical fitness and facilitates social inclusion.

Within this framework, the current investigation seeks to explore the impact of a structured aquatic activity intervention program on psycho-behavioral and social-emotional variables in adolescents diagnosed with Down syndrome, using the Strengths and Difficulties Questionnaire (SDQ) as the main standardized assessment instrument.

Although the benefits of aquatic activities on the overall health of people with disabilities are well documented, studies rigorously examining the effects of these interventions on psychological dimensions among young people with Down syndrome are still limited, especially when standardized psychometric instruments are used for assessment (Alghamdi et al., 2021).

The present study has examined the influence of aquatic activities on the emotional wellbeing of individuals diagnosed with Down syndrome. The inherent characteristics of water, including buoyancy and resistance, create a distinct setting that supports mobility and coordination. Thus, we hypothesized that aquatic activities, as a complementary form of therapeutic intervention, can achieve substantial changes on some psychological difficulties as well as on prosocial behavior in young people with Down syndrome.

Literature review

Physical activity-based interventions, especially those carried out in aquatic environments, have been frequently emphasized in the literature for their positive impact on both the physiological well-being and psychological functioning of individuals with disabilities, contributing to improved motor skills, reduced stress levels and social development (Oltean et al., 2025). Aquatic activities, due to the properties of the environment in which they take place, offer favorable conditions for stimulating motor skills, reducing mental tension and increasing general well-being (Tsolakiet al., 2023).

Methodology

The sample of participants consisted of 34 adolescents diagnosed with Down syndrome, aged between 14 and 18 years old (mean 16.06±1.09), from the Down Association Bucharest. All participants were declared medically fit for aquatic activities and parental informed consent was obtained prior to the commencement of the intervention. The target group was defined through the administration of a questionnaire to the parents or legal guardians of the adolescents, aimed at determining whether the participants had previously received any form of therapy, specifying the type and duration. The primary inclusion criterion focused on selecting individuals who had not previously undergone any therapeutic interventions, particularly those involving aquatic therapy.

The Strengths and Difficulties Questionnaire (SDQ), developed by Goodman (1997), was used to assess participants in this research. It is a validated psychometric instrument frequently employed in evaluating psychosocial and behavioural challenges among children and adolescents, and is offered in both self-report and parent/teacher formats. The Strengths and Difficulties Questionnaire (SDQ) comprises 25 items, grouped into five distinct subscales: emotional symptoms (scores of 0–3 indicating a normal range, 4 suggesting a borderline level, and 5–10 reflecting abnormality), conduct problems (0–2 normal, 3 borderline, 4–10 abnormal), hyperactivity (0–5 normal, 6 borderline, 7–10 abnormal), peer relationship difficulties (0–2 normal, 3 borderline, 4–10 abnormal), and prosocial behaviour (6–10 normal, 5 borderline, 0–4 indicating low prosocial functioning)(Goodman, 1997). Each item can be rated and counted as "Not True" with 0, "Somewhat True" with 1 or "Certainly True" with 2 (Goodman et al., 1998).

Data analysis was performed using Microsoft Excel (with the Kutools extension) and IBM SPSS Statistics, version 25 (Mircică et al., 2024).

Participants were initially assessed using the Strengths and Difficulties Questionnaire (SDQ), completed by parents. The parent or guardian who completed the questionnaire was not informed about the specific therapeutic programme in which the adolescent would be involved. They were invited to the Association's headquarters to complete the questionnaire both prior to and following the intervention. Subsequently, they participated in a structured programme of aquatic activities over a period of six months, with sessions held twice weekly, each with a duration of 60 minutes. The aquatic sessions were delivered by specialists from the Atack Team Sports Club and were conducted on an individual basis at the swimming pool of the University of Medicine and Pharmacy "Carol Davila" in Bucharest (UMF "Carol Davila"). The program included swimming exercises, aquatic games and motor therapy activities in the aquatic environment, all adapted to the individual needs of the participants. It is important to note that, throughout the duration of the project, the adolescents did not engage in any additional therapeutic interventions. Upon completion of the intervention, the questionnaire was administered again to the parent/guardian, in order to evaluate potential changes in the participants' emotional and behavioral profiles.

Results

Paired samples t-test was used to analyze the data in order to assess statistical significance and control for variance. For this purpose, sets of scores were used for a group of subjects measured twice, initial test and final test, and their means were compared with the Kutools extension.

Emotional Symptoms Score

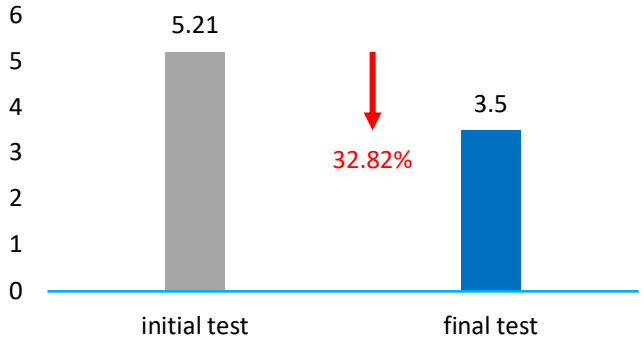
Table 1. Descriptive statistics for emotional symptoms scale scores

test	minimum	maximum	mean	std. error	median	std. deviation	mean difference
initial	4	6	5.21	.092	5	0.538	1.71
final	3	4	3.50	.087	3.5	0.508	

* Table adapted from *Mircică et al. (2024)*. The data are the authors' own results.

Based on the descriptive data regarding emotional symptoms, it is evident that the highest scores decreased considerably in the final assessment compared to the initial one, with a standard error of the mean of only 0.087. Furthermore, the average scores between the two assessments reveal a difference of 1.71 in favour of the final test, indicating a statistically significant reduction (table 1).

Figure 1. Analysis of mean emotional symptomsscores



Source: authors' own concept

Figure 1 demonstrates a 32.82% average increase in mean scores from the initial to the final test, indicating significant participant improvement.

Table 2. T-test for dependent samples for emotional symptoms

test	paired differences					t	df.	sig. (2-tailed)
	mean	std. deviation	std. error mean	95% confidence interval of the difference				
				lower	upper			
initial - final	*1.71*	.462	.079	1.545	1.867	21.5	33	0.000

* Table adapted from *Mircică et al. (2024)*. The data are the authors' own results.

The value of t, based on the mean divided by the standard error of the mean, is 21.5 for the paired-samples at initial and final testing. As the confidence interval, ranging from 1.545 to 1.867, excludes 0.00 and the p-value is less than 0.001, there is sufficient statistical evidence to reject the null hypothesis at the 5% level. This interval also offers sufficient information to support the interpretation of statistical significance.(table 2).

Conduct Problems Score

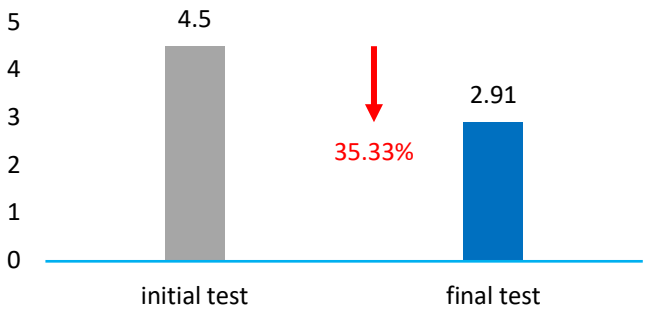
Table 3. Descriptive statistics for scores on the conduct problems scale

test	minimum	maximum	mean	std. error	median	std. deviation	mean difference
initial	4	5	4.5	.087	4.5	0.508	1.58
final	2	4	2.91	.077	3	0.452	

* Table adapted from *Mircică et al. (2024)*. The data are the authors' own results.

Based on the descriptive data regarding conduct problem, it is evident that the highest scores decreased considerably in the final assessment compared to the initial one, with a standard error of the mean of only 0.077. Furthermore, the average scores between the two assessments reveal a difference of 1.58 in favor of the final test, indicating a statistically significant reduction (table 3).

Figure 2. Analysis of mean conduct problems scores



Source: authors' own concept

Figure 2 demonstrates a 35.33% average increase in mean scores from the initial to the final test, indicating significant participant improvement.

Table 4. T-test for dependent samples for conduct problems

test	**paired differences**					t	df.	sig. (2-tailed)
	mean	std. deviation	std. error mean	95% confidence interval of the difference				
				lower	upper			
initial - final	*1.58*	.609	.104	1.376	1.801	15.209	33	0.000

* Table adapted from *Mircică et al. (2024)*. The data are the authors' own results.

The value of t is 15.209 for the paired-samples at initial and final testing. Since the confidence interval does not include the value 0.00 and the significance threshold is $p < 0.001$, the interval ranging from 1.376 to 1.801 provides sufficient evidence to reject the null hypothesis at the 5% significance level. Moreover, the confidence interval contains adequate information to allow for a reliable assessment of statistical significance (table 4).

Hyperactivity Score

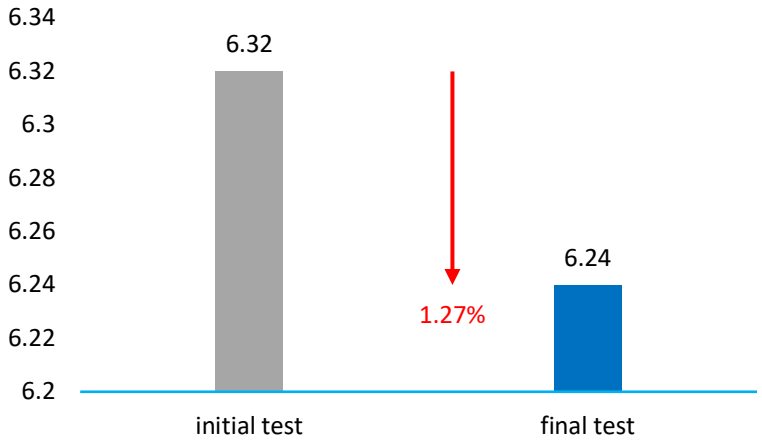
Table 5. Descriptive statistics for hyperactivity scale scores

test	minimum	maximum	mean	std. error	median	std. deviation	mean difference
initial	6	7	6.32	.081	6	0.475	0.088
final	5	7	6.24	.095	6	0.554	

* Table adapted from *Mircică et al. (2024)*. The data are the authors' own results.

From the descriptive statistic for hyperactivity, one can observe slightly altered values in the final assessment relative to the initial measurement. Similarly, the difference in average scores between the two assessments is minimal, with a value of only 0.088 observed in the final test. This change, however, does not reach statistical significance, indicating a marginal and likely non-meaningful variation. (table 5).

Figure 3. Analysis of mean hyperactivity scores



Source: authors' own concept

As illustrated in Figure 3, the comparison between the average scores of the initial and final tests reveals a limited improvement in participants' performance, amounting to an increase of just 1.27% compared to the initial assessment.

Table 6. T-test for dependent samples for hyperactivity

test	paired differences					t	df.	sig. (2-tailed)
	mean	std. deviation	std. error mean	95% confidence interval of the difference				
				lower	upper			
initial - final	*.088*	.288	.049	-.012	.189	1.787	33	0.083

* Table adapted from *Mircică et al. (2024)*. The data are the authors' own results.

The value of t is 1.787 for the paired samples at initial and final testing. Since the confidence interval passes through the value of 0.00 and the significance threshold with a confidence interval range from -0.012 to 0.189, this shows us that the difference is not statistically significant at a two-level 5% level of significance (table 6).

Peer Problems Score

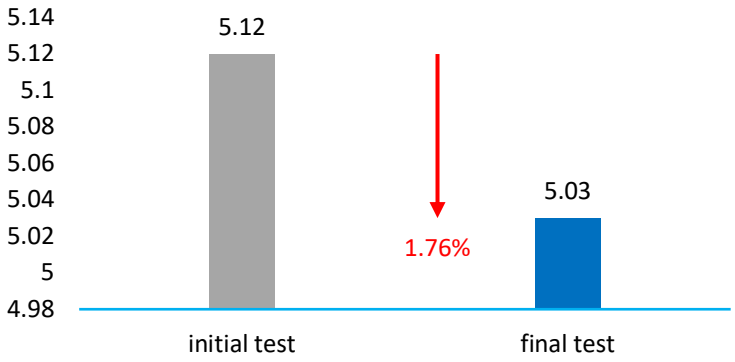
Table 7. Descriptive statistics for the scores obtained on the peer problems scale

test	minimum	maximum	mean	std. error	median	std. deviation	mean difference
initial	5	6	5.12	.056	5	0.327	0.08
final	5	6	5.03	.029	5	0.171	

* Table adapted from *Mircică et al. (2024)*. The data are the authors' own results.

The descriptive statistics related to peer problems show minor variations in scores between the final and initial assessments. Furthermore, the comparison of mean values reveals a marginal difference of 0.08 in favor of the final test, representing a reduction that does not reach statistical significance. (table 7).

Figure 4. Analysis of mean peer problems scores



Source: authors' own concept

As presented in Figure 4, the comparison of average scores from the initial and final assessments indicates only a minimal improvement, with an increase of 1.76%, suggesting limited progress among participants.

Table 8. T-test for dependent samples for peer problems

test	**paired differences**					t	df.	sig. (2-tailed)
	mean	std. deviation	std. error mean	95% confidence interval of the difference				
				lower	upper			
initial - final	*.08*	.288	.049	- .012	.189	1.787	33	.083

* Table adapted from *Mircică et al. (2024)*. The data are the authors' own results.

The value of t is 1.787 for the paired samples at initial and final testing. Since the confidence interval passes through the value of 0.00 and the significance threshold with a confidence interval ranges from -0.012 to 0.189 shows us that the difference is not statistically significant at a two-tailed 5% level of significance (table 8).

Prosocial Behavior Score

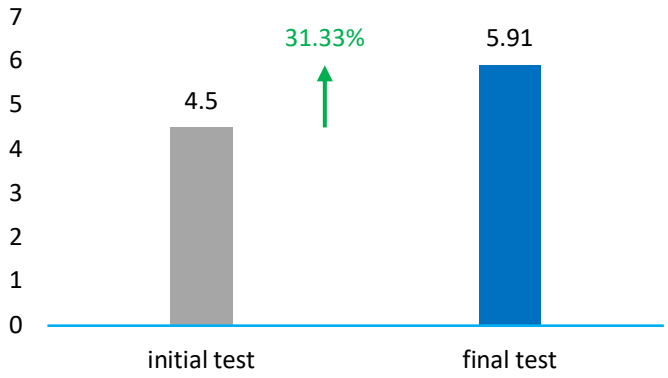
Table 9. Descriptive statistics for prosocial behavior scale scores

test	**minimum**	**maximum**	**mean**	**std. error**	**median**	**std. deviation**	**mean difference**
initial	4	5	4.5	.087	4.5	0.508	1.41
final	5	7	5.91	.098	6	0.570	

* Table adapted from *Mircică et al. (2024)*. The data are the authors' own results.

An examination of the descriptive statistics for prosocial behaviour reveals that the highest scores increased markedly in the final assessment relative to the initial test. Similarly, the difference in average scores between the two assessments is minimal, with a value of only 1.41 observed in the final test. This change, however, does not reach statistical significance, indicating a marginal and likely non-meaningful variation (table 9).

Figure 5.Analysis of mean prosocial behavior scores



Source: authors' own concept

Figure 5 demonstrates a 31.33% average increase in mean scores from the initial to the final test, indicating significant participant improvement.

Table 10. T-test for dependent samples for prosocial behavior

test	**paired differences**					t	df.	sig. (2-tailed)
	mean	std. deviation	std. error mean	95% confidence interval of the difference				
				lower	upper			
initial - final	*-1.41*	.500	.086	-1.586	-1.237	-16.479	33	0.000

* Table adapted from *Mircică et al. (2024)*. The data are the authors' own results.

The value of t, for the initial and final test is -16.479. Since the confidence interval, ranging from –1.586 to –1.237, does not include 0.00 and the p-value indicates statistical significance, there is sufficient evidence to reject the null hypothesis at the 5% significance level. Additionally, the

confidence interval offers adequate information to support the evaluation of statistical significance. (table 10).

Discussions

Adolescents with Down syndrome experience a general delay in the development of the central nervous system; however, during adolescence, modest improvements may occur in coordination, muscle tone (as hypotonia may become less pronounced), balance, and postural control. Observable enhancements in coordination, balance, or muscular endurance are more likely to result from structured activities, such as aquatic movement, rather than from spontaneous maturation (Ting et al., 2023). This approach reinforces the assertion that the findings support the hypothesis that aquatic activities, as a complementary form of therapeutic intervention, can achieve substantial changes on some psychological difficulties as well as on prosocial behavior in young people with Down syndrome. These findings are in agreement with the literature, which highlights the favorable impact of physical exercise on the reduction of anxiety and depressive symptoms, as well as on the reduction of problematic behaviors (Rimmer et al., 2007; Henriksson et al., 2022).Positive outcomes following the implementation of an aquatic exercise programme can also be observed in motor coordination and balance among adolescents with Down syndrome, as supported by Méndez-Martínez& Rodríguez-Grande(2023). These improvements may be attributed to the low resistance and supportive nature of the aquatic environment, which facilitates safer execution of movements. However, the absence of significant changes in the dimensions of hyperactivity and peer relationship difficulties suggests that these behavioral aspects may require more targeted and individualized interventions, possibly involving small group work (3–4 participants) over an extended period, in order to achieve noticeable improvements.

The constraints of the research involve the limited number of participants and the absence of a comparison group, factors that may influence the generalizability of the results. Also, the lack of a differentiated analysis by age, degree of cognitive impairment or level of autonomy limits our understanding of how individual variables may influence the response to intervention. In this respect, future research should adopt a more robust methodological design, including both experimental and control groups, as well as a long-term follow-up of the participants' evolution, to assess the sustainability of the observed benefits.

We mention that this study, due to the fact that the activity is carried out in the swimming pool of UMF "Carol Davila", has the approval of the

Department 9through Decision no. 53/26 November 2024, and fully adheres to established ethical standards. At the same time, all subjects participated voluntarily with written parental consent, and ethical standards were fully upheld in line with the principles outlined in the Declaration of Helsinki.

Conclusions

The aquatic activities program had a significant positive impact on certain dimensions of emotional and behavioral difficulties in the young people with Down syndrome included in the study.

In particular, there were statistically significant improvements in emotional symptoms and behavioral problems, with an average decrease of approximately 34% from baseline assessments. The high t-test values for dependent samples (21.5 and 15.209), together with significance thresholds $p < 0.001$ and confidence intervals that do not include the value 0, provide robust evidence against the null hypothesis and substantiate the efficacy of the aquatic intervention in reducing these aspects of behavioral difficulties.

A statistically significant increase was also observed for prosocial behavior, which improved on average by 31.33%. The negative value of t (-16,479) reflects a clear difference between the pre- and post-intervention assessments, supported by a confidence interval that does not include the value 0 and thus confirms the statistical significance of the results.

In contrast, the dimensions of hyperactivity and peer relationship problems did not show statistically significant changes. The very small mean decreases of about 1.51% and t-values close to the significance limit and the confidence interval passing through the value 0 indicate that the difference is not statistically significant at a two-tailed significance level of 5%. This suggests that a longer intervention period and small-group work may be necessary to produce notable effects in these two areas as well.

Overall, the findings support the use of aquatic activities as an effective complementary method of intervention to ameliorate emotional and behavioral difficulties as well as to stimulate prosocial behavior in young people with Down syndrome. At the same time, the results emphasize the importance of adapting the intervention according to the particularities of each behavioral dimension.

Thus, in view of the results obtained, we believe that it is necessary to consider aquatic activities as an integral part of therapeutic programs for young people with Down syndrome. In particular, these activities can be an effective tool for relieving emotional symptoms, reducing oppositional behaviors and strengthening prosocial behavior

Acknowledgments

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