Journal of Exercise Physiologyonline

Volume 15 Number 2 April 2012

Official Research Journal of the American Society of Exercise Physiologists

ISSN 1097-9751

JEPonline

Beneficial Effects of Clinical Exercise Rehabilitation for Children and Adolescents with Autism Spectrum Disorder (ASD)

Jane E Magnusson[1], Caitlin Cobham[2], Rachel McLeod[3]

[1]Department of Sport & Exercise Science; University of Auckland, Auckland, New Zealand, [2]Exercise Rehabilitation Clinic, University of Auckland, New Zealand, 3Department of Psychology, University of Auckland, New Zealand

ABSTRACT

Magnusson JE, Cobham C, McLeod R. Beneficial Effects of Clinical Exercise Rehabilitation for Children and Adolescents with Autism Spectrum Disorder (ASD). **JEPonline** 2012;15(2):71-79. Although exercise programs have shown health and behavioral benefits for individuals with Autism Spectrum Disorder (ASD), more information is needed about the types of exercise used and how programs are designed to enhance their effectiveness. The purpose of the current study was to investigate if an individually-tailored, high-intensity exercise program would have a positive effect on the physical fitness and behaviors of children and adolescents with ASD. Assessments of physical fitness and positive/negative behaviors were undertaken pre- and post-intervention. Improvements across all physical fitness and behavioral variables tested were found following participation in the exercise program. These findings demonstrate that a high-intensity exercise-based program administered with an ASD population is an effective method to improve ASD-specific issues as well as health and fitness variables in this population.

Key Words: Autism, Asperger's, PPD-NOS, Exercise, Physical Activity, Sleep

INTRODUCTION

Autistic Spectral Disorders (ASD) are a range of neuro-developmental disorders that include autism, Asperger syndrome, and pervasive developmental disorder not otherwise specified (PPD NOS) (9,16). The characteristics of ASD include deficits in cognitive processing, impaired social interactions, delayed or limited communication skills, and restrictive patterns of activities or interests (1). Disturbed sleep is another symptom commonly experienced by children with ASD with estimates ranging between 44% and 83% (2,14). Impairments with motor behaviors are also seen in those with ASD (11), which can impede aspects of daily functioning as well as ability to undertake such physical activities as exercise. As the health risks of a sedentary lifestyle are more common among individuals with intellectual and developmental disabilities such as ASD compared to those without the developmental disabilities (7,9,12), finding ways to increase activity levels in this population is necessary to reduce the likelihood of negative health consequences.

Exercise as a Treatment for ASD

In their review of physical activity with ASD individuals, Lang et al. (9) report that all the studies reviewed showed improvements across many domains. These included negative behaviors (e.g., stereotypy, aggression, and self-injury), positive behaviors (e.g., ability to focus and stay on task and academic performance), physical fitness (e.g., endurance or strength), and exercise behavior (e.g., more time engaged in exercise). With regard to the type of exercise undertaken, it was found that vigorous exercise had a more pronounced effect than milder, less strenuous exercise (9). Exercise interventions may also be beneficial for individuals with ASD in relation to sleep disturbances as they have been shown to reduce sleep onset latency and improve sleep quality in other populations (5,8,18).

In addition to the health and behavioral benefits of exercise programs, for those working with ASD individuals, one of the benefits of an antecedent approach such as exercise is that the intervention is preventative as it occurs before the behavior takes place, thus reducing the motivation to perform the behavior (6). This approach is therefore less demanding of an intervener's behavior management skills (17) and more cost-effective than contingency management procedures (3).

Need for Additional Research

As reported by Lang et al. (9) most studies on the use of exercise with ASD individuals were undertaken with those diagnosed with autism. More studies are needed to investigate the effects of exercise across the spectrum of ASD disorders. More information is also needed about the procedures used to teach and maintain exercise with ASD individuals (9). For example, more clarity is required in relation to exercise parameters and how programs are designed. Specific guidelines in relation to the type, dose, intensity, duration, and frequency of the exercise specified could enhance the benefits of exercise for ASD individuals.

The purpose of this study was to determine if an exercise program tailored to enable moderate to high-intensity activity would benefit children and adolescents with ASD by having a positive effect on their behavior, physical fitness, and sleep. The approach of this study was unique in that to increase the likelihood that the exercise programs were maximally effective, an Exercise Rehabilitation Specialist familiar with ASD designed and monitored the exercise programs for each participant. This feature of the study helped to ensure the appropriateness of the programs for each participant's fitness level and physical capabilities. It was expected that the approach of using quantified measures such as heart rate and exercise intensity, as well as observational behavioral measures, would provide a greater understanding of how exercise affects individuals with ASD.

METHODS

Subjects

The recruitment of subjects through schools, a specialized hospital youth unit, an autism community group, and the University's Exercise Rehabilitation Clinic and the study procedures were approved by the University's Human Ethics Committee. All subjects were diagnosed with ASD (e.g., autism, Asperger's, or PDD NOS) or had disruptive behaviors (e.g., self-stimulating, disrupted sleep patterns). The subjects had sufficient receptive language to follow the instructions of the researchers, and had sufficient motor skills to do the exercises prescribed. The subjects had to be in good general health as determined by a medical certificate from their General Practitioner (GP), which cleared them to participate in an exercise program and to exercise up to a maximal level. If a subject displayed high levels of aggression, if the motor skills were not adequate for the exercises, and if the subject's receptive language skills were not sufficient to follow instructions, or, then, the subject was excluded from the study. The subjects were also excluded if they did not have medical clearance from their GP. As all subjects were under the age of 16, consent to take part in the study was obtained from their parent/guardian. Willingness to take part in the exercise program was obtained verbally from participants at the start of every session. Six subjects met the inclusion criteria (4 males and 2 females, aged 9 to 15 yrs old). Their parent or guardian consented for them to take part in the study. Diagnoses of participants included autism (n=4), Asperger's (n=1) and ASD/PDD NOS (n=1).

Completion of Questionnaires

The parent or guardian completed measures on behalf of their child. These included a general health assessment, behavior screening questionnaire, and a section regarding their child's triggers and motivators. They also answered questions regarding the occurrence of negative (e.g., self-stimulatory behaviors, self-harm, physical and/or verbal aggression towards others) and positive behaviors (e.g., academic performance, willingness to participate in physical activities, and social skills). The parents and guardians were asked to indicate which problem behaviors were of most concern to them, how frequently their child engaged in the behaviors (0 = not frequent to 10 = very frequent), and how much the behavior interfered with daily living (0 = does not interfere to 10 = interferes a lot).

Familiarization Session

A familiarization session was conducted once all measures were completed. This session included an interview with the parent or guardian and their child to discuss medical history, past exercise, severity of ASD and any other clinical diagnoses or health conditions. The familiarization session was conducted within the facilities the subjects would be exposed to during the study to familiarize them with the equipment and surroundings.

Testing Protocol

During the first session the subjects' height, weight, and blood pressure were measured. Then, they undertook a thorough physical testing protocol that included measures of cardiorespiratory fitness, upper and lower body strength, abdominal strength and endurance, lower back and hamstring flexibility and balance (see Table 1).

Table 1. Physical Exercise Test for Youth with ASDs.

Cardiorespiratory Fitness	Upper Body Strength	Lower Body Strength	Abdominal Strength and Endurance	Hamstring and Lower Back Flexibility	Standing Balance
Modified Bruce Protocol (4,10)	1RM Bench Press/Maximal Press-Up Test	1RM Leg Press	Maximal Curl-Up Test	Sit and Reach Test	Modified Romberg Test

Exercise Sessions

Sessions were run on a one-on-one basis with the researcher and subject. Participants took part in the exercise program twice a week for 8 to 12 wks to achieve a total number of 16 exercise sessions and two 'testing' sessions (i.e., baseline and follow-up data collection). Each program had cardio and resistance components. For one session, the subject completed the cardio component. For the second session, the subject completed both the cardio and the resistance components. Sessions were approximately 1 hr in duration.

While programs were tailored to each subject, all programs included a warm-up, high-intensity interval training, aerobic exercises, plyometric training, resistance training, a warm-down and stretches. The combination of activities in the resistance component of the program varied from subject to subject, but the same core activities were used (e.g., box jumps, box step up with medicine ball throw, press-ups, and curl-ups). The resistance level, length of intervals, and speed of running for exercise programs were based on each subject's fitness level and progress. As the subjects increased their cardiovascular endurance the intervals were adjusted for time and speed. The amount of calories expended on each machine was recorded along with heart rate to ensure that the subjects were obtaining the maximum benefit from the exercise program. If it was not possible to use a heart rate monitor, heart rate was obtained manually.

Reward Systems to Facilitate Exercise Participation

To facilitate participation in the exercise program, a reward system individualized to each subject was used. Some subjects used a visual schedule whereby the session's activities were posted on a board in a linear fashion with the number of pictures of each activity indicating how long it would last. Other subjects used a direct reward system (i.e., at the end of the session they were allowed to pick from a 'treat box' something their parent or guardian indicated they found rewarding). Some subjects did not require a reward to fully engage in the exercise sessions.

Post-Intervention Testing Session

At the completion of the 16 exercise sessions, the subjects were re-assessed using the same protocol as the initial testing session. Parents or guardians completed questionnaires regarding their child's negative and positive behaviors and rated how much their child's behavior had changed since taking part in the exercise program (0 = not changed to 10 = changed a lot).

RESULTS

Measures of Health and Physical Activity

All subjects exhibited overall improvement in the measures of physical fitness with statistically significant changes in cardiorespiratory fitness ($z = -2.201$, $P<0.05$) (see Table 2) and abdominal strength ($z = -2.207$, $P<0.05$) (see Table 3). Improvement on the measure of hamstring and lower back flexibility approached significance ($P=0.066$). All subjects improved their upper and lower body strength, but the changes did not reach statistical significance. Results on the tests of standing balance were variable, but failed to show statistically significant improvements.

Table 2. Mean Scores for Cardiorespiratory Fitness Pre- and Post-Exercise Intervention.

	Pre	Post
Cardiorespiratory Fitness ($mL \cdot kg^{-1} \cdot min^{-1}$)	1.76	2.34

Table 3. Mean Scores for Measures of Physical Activity Pre- and Post-Exercise Intervention.

Measure of Physical Activity	Pre	Post
Mean curl ups	15.50	30.70
Mean sit and reach	-14.30	-9.00
Mean press-ups (n=4)	6.75	13.75
Mean bench press (kg) (n=2)	16.50	19.50
Mean leg press (kg)	50.00	61.70
Mean standing balance (L)	20.30	23.10
Mean standing balance (R)	23.20	25.70

Measures of Positive and Negative Behaviours

All positive behaviors improved with statistically significant improvements being found for 'attention to task' ($z = -2.207$, $P<0.05$), 'positive behaviors towards exercise' ($z = -2.032$, $P<0.05$), 'voluntary participation in physical activity (unstructured)' ($z = -2.032$, $P<0.05$) and 'positive participation in physical activity' ($z = -2.032$, $P<0.05$) (see Table 4). Improvements in positive behaviors related to 'academic performance' and 'social skills' approached significance ($P=0.068$ and 0.063, respectively). Although negative behaviors were reduced at post-intervention testing, the improvements did not reach statistical significance (see Table 5). Statistically significant improvements were found for the frequency of problematic behaviors identified by parents and guardians ($z = -2.52$, $P<0.05$) and how much these behaviors were interfering with daily life ($z = -2.54$, $P<0.05$) (see Table 6). At the post intervention assessment, all parents and guardians reported their child's behavior had improved following participation in the exercise program (see Table 7).

Table 4. Mean Scores for Positive Behaviours Pre- and Post-Exercise Intervention.

	Mean Pre	Mean Post
Academic performance	5.33	7.17
Attention to task	4.50	7.17
Social skills	4.50	6.50
Positive behavior towards exercise	6.17	8.67
Voluntary participation in physical activity	4.83	7.17
Positive participation in physical activity	3.67	6.17

Table 5. Mean Scores for Negative Behaviors Pre- and Post-Exercise Intervention.

	Mean Pre	Mean Post
Self-stimulatory behaviors	5.00	3.50
Self-harm	3.00	2.00
Physical aggression	2.33	1.33
Verbal aggression	3.00	1.83

Table 6. Parent/Guardian Ratings of Problematic Behaviors and How Much They Interfere with Daily Living.

Participant	Type of Problem Behavior	Frequency of Problem Behavior		Interfering with Daily Life	
		Pre	Post	Pre	Post
1	**Obsessive**	10	6.5	10	9
1	**Sleep**	8	3	8	6
2	**Stimming**	10	2	8	3
2	**Sleep**	9	2	10	3
3	**Verbal abuse**	7	6	8	8
3	**Sleep**	8	n/a	8	n/a
4	**Verbal abuse**	7	5	8	6
4	**Aggressive**	7	1	8	6
5	**Stimming**	8	6	9	4
5	**Sleep**	6	n/a	7	n/a
6	**Stimming**	7	7	6	2

Table 7. Parent/Guardian Rating of Overall Behaviour Change at Post-Intervention Assessment.

Participant	Overall Rating of Behavior Change
1	10
2	9
3	7
4	9
5	9
6	5

DISCUSSION

It is well known that issues such as weight and physical fitness need to be managed in childhood and adolescence to avoid the multitude of health risks associated with being overweight or obese, and this risk is increased for individuals with ASD as the condition leads to a more sedentary lifestyle than age-matched individuals without ASD (13,15). Engaging ASD individuals in exercise programs represents an the opportunity to demonstrate that exercise intervention improves their health and well-being.

The results of this study indicate that the benefits of engaging individuals with ASD in an individually-tailored, high-intensity exercise program improves all physical fitness and behavioral outcomes for cardiorespiratory fitness and abdominal strength as well as positive behaviors towards exercise, voluntary participation in physical activity (unstructured), and positive participation in physical activity.

These improvements in physical functioning are encouraging as they show that with the right activities, changes in this population can be achieved which have real-world relevance. As an example, the improvement in abdominal strength and endurance is important as core strength is vital in maintaining correct posture, supporting balance, and preventing lower back injuries. Although improvements in the other measures of physical fitness failed to meet statistical significant, their clinical significance should still be considered since the subjects showed improvement across these variables. In addition to benefits related to physical fitness, taking part in the exercise program was believed beneficial in relation to the increase in positive behaviors and reduced negative behaviors. The improvements in behaviors seen in this study are therefore encouraging as they indicate that an antecedent approach (such as exercise) may have beneficial effects beyond the exercise session and hence may pro-actively help to enhance positive behaviors and prevent the occurrence of problematic behaviors.

In addition to demonstrating the benefits of an exercise program for ASD subjects, the present study provides guidance with regard to the type of exercise program that is beneficial for this population and the components that should be included. When designing an exercise program for ASD subjects, it is important to note that where previous studies have used generic exercise protocols, the exercise programs in the current study were designed by an Exercise Rehabilitation Specialist familiar with ASD and individualized to each subject. This approach allowed for the development of programs that were appropriate to each subject's physical abilities and needs. The current study also used stringent measures to assess the physical changes from pre- to post-intervention thereby providing a guideline for how to optimize the benefits of an exercise program for ASD individuals.

In addition to using specific measures of physical fitness, the present study monitored the heart rate of subjects, which is an essential aspect of an exercise program as it ensured that the subjects were working within their target heart rate and it enabled their program to be increased in intensity relative to their improved fitness levels. While the individualization of each subject's program could limit the generalizability of the findings to less structured, more generic exercise programs, the essential aspects of the programs used common exercise techniques and can, therefore, be applied across different exercise settings.

CONCLUSIONS

The current study demonstrated that an individualized, high-intensity exercise program is an effective method for improving health and fitness, reducing negative behaviors, and in improving positive behaviors of children and adolescents with ASD. Results of the pre- and post-intervention ratings by parents and guardians indicate that the frequency of problematic behaviors and how the behaviors interfere with daily life were significantly reduced following participation in the exercise programs. The benefits of using exercise as an intervention include its cost-effectiveness and potentially preventative nature compared to other behavioral interventions. However, it should be noted that to maximize the effectiveness and hence the benefits of an exercise program, it should be developed in consultation with those who have sufficient expertise in exercise physiology and, in particular, exercise in specialized populations.

Address for correspondence: Jane E Magnusson, Department of Sport and Exercise Science, University of Auckland, Private Bag 92019, Auckland, New Zealand, 1142. E-mail: j.magnusson@auckland.ac.nz. Email: j.magnusson@auckland.ac.nz Phone: +6493737599 ext. 88278, Fax: +6493737043

REFERENCES

1. American Psychiatric Association (APA). ***Diagnostic and Statistical Manual of Mental Disorders.*** Fourth Edition. Washington, DC: American Psychiatric Association, 2000.

2. Andersen IM, Kaczmarska J, McGrew SG, Malow BA. Melatonin for insomnia in children with ASDs. ***J Child Neurol***. 2008;23:482-485.

3. Bachman JE, Fuqua RW. Management of inappropriate behaviours of trainable mentally impaired students using antecedent exercise. ***J Appl Behav Anal.*** 1983;16:477-484.

4. Bruce RA, Kusumi F, Hosmer D. Maximal oxygen intake and nomographic assessment of functional aerobic impairment in cardiovascular disease. **Am Heart J.** 1973;85:545-562.

5. Chen MY, Wang EK, Jeng YJ. Adequate sleep among adolescents is positively associated with health status and health-related behaviours. ***BMC Public Health***. 2006;6:1-8.

6. Cooper JO, Heron TE, Heward WL. ***Applied Behaviour Analysis***. Second Edition. Pearson Education Inc. New Jersey, 2007.

7. Draheim CC, Williams DP, McCubbin JA. Prevalence of physical activity and recommended physical activity in community-based adults with mental retardation. ***Mental Retard***. 2002;40:436-444.

8. Dworak M, Wiater A, Alfer D, Stephan E, Hollmann W, Struder HK. Increased slow wave sleep and reduced stage 2 sleep in children depending on exercise intensity. ***Sleep Med***. 2006;9:266-272.

9. Lang R, Koegel LK, Ashbaugh K, Regester A, Ence W, Smith W. Physical exercise and individuals with autism spectrum disorders: A systematic review. ***Res Autism Spect Dis***. 2010;4:565-576.

10. Lerman J, Bruce RA, Sivarajan E, Pettet, GM, Trimble S. Low level dynamic exercises for earlier cardiac rehabilitation: aerobic and hemodynamic responses. **Arch Phys Med Rehab.** 1976;57:355-360.

11. Ozonoff S, Young GS, Goldring S, Greiss-Hess AM, Steele J, et al. Gross motor development, movement abnormalities, and early identification of autism. ***J Autism Devel Disord.*** 2008;38:644-656.

12. Pan CY. School time physical activity of students with autism spectrum disorders and students without disabilities during inclusive physical education and recess in Taiwan. ***Adapt Physi Act Quart***. 2008;25:308–321.

13. Pitetti KH, Rendoff AD, Grover T, Beets MW. The efficacy of the 9 month treadmill walking programme on the exercise capacity and weight reduction for adolescents with severe Autism. ***J Autism Devel Disord.*** 2007;37:997-1006.

14. Richdale AL. Sleep problems in Autism: prevalence, cause, and intervention. ***Devel Med Child Neurol.*** 1999;41:60-66.

15. Robertson J, Emerson E, Gregory N, Hatton C, Turner S, Kessissoglou S, Hallam A. Lifestyle related risk factors for poor health in residential settings for people with intellectual disabilities. ***Res Develop Disabi.*** *2000;*21:469–486.

16. Sturmey P, Fitzer A. ***Autism Spectrum Disorders: Applied Behaviour Analysis, Evidence, and Practice***. Austin, TX: Pro-Ed, 2007.

17. Watters RG, Watters WE. Decreasing self-stimulatory behaviour with physical exercise in a group of autistic boys. ***J Autism Develop Disord****.* 1980;10: 379-387.

18. Youngstedt SD, Kline CE. Epidemiology of exercise and sleep. ***Sleep Biol Rhyth****.* 2006;(4):215-221.