Ann Appl Sport Sci, InPress(InPress): e1201.
http://www.aassjournal.com; e-ISSN: 2322–4479; p-ISSN: 2476–4981. 10.52547/aassjournal.1201

ORIGINAL ARTICLE

A Guided Physical Activity Intervention for Fundamental Motor Skill Improvement in Children with Autism

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Submitted March 20, 2022; Accepted in final form May 7, 2023.

ABSTRACT

Background. Motor skill teaching interventions with a skill education component effectively improve fundamental motor skills (FMS) in children with Autism (ASD). However, few studies have considered if self-directed physical activity with a guide is sufficient to enhance FMS in this population. **Objectives.** This study explored whether guided physical activity improves FMS in children with ASD and examined if benefits for ASD children were greater than for typically developing children. **Methods.** Children with ASD (n = 4) and typically developing (n = 7) children were recruited to participate in a 10-week guided physical activity intervention. The intervention consisted of four 12-minute activity stations structured according to the North Carolina Treatment and Education of Autistic and Related Communications-Handicapped Children. Children engaged in self-directed play at each station, and guides provided support when requested. **Results.** Preliminary findings support that guided physical activity has the potential to enhance running (t = 2.6, p = .08) and kicking (t = 2.36, p = .07) in children with ASD. However, FMS gains in ASD children did not exceed gains made by typically developing children. **Conclusion.** The effect of guided physical activity for children with ASD should be explored in larger studies as this type of intervention may be feasible to deploy in multiple settings. **Highlights.** Guided physical activity may be a feasible and effective means of supporting FMS development in children with ASD.

KEYWORDS: ***Autism, Motor Skills, Physical Activity, Intervention***

INTRODUCTION

Autism Spectrum Disorder (ASD) is a prevalent neurodevelopmental condition affecting 1 in every 44 children in the United States (1). Children with ASD struggle with communication and social interaction and demonstrate restricted interests and behaviors (2, 3). Additionally, data support that children with ASD are not proficient in fundamental motor skills (FMS) (4, 5). FMS are basic locomotor (e.g., running, jumping, hopping) and object manipulation (e.g., throwing, catching, kicking) skills that support childhood physical activity and serve as the foundation for complex motor skills in sports and recreational activities (6). Achieving proficiency in FMS has been deemed a pillar of healthy child development given research demonstrating that children who do not master these skills by the end of childhood are less physically active and less healthy than others (7-9). Thus, addressing FMS in children with ASD is imperative.

Research supports that tailored physical education and physical activity interventions

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enhance FMS in children with ASD (10, 11). Bremer and Lloyd reported improved jump, strike, roll, and catching performance in 3-7-year-old ASD participants after a twelve week, school-based fundamental motor skill intervention (12). Further, teachers involved in the intervention reported that it had a "huge impact on all of their (ASD participants) motor skills…no matter what level they were first" (12). Other effective interventions have used soccer (13, 14), dance (15), rock climbing (16), tai chi (17), table tennis (18), and multi-sport community programs (19) to enhance motor skills in children with ASD. While many studies have considered if structured physical activity enhances motor skills in children with ASD, few studies have examined if guided physical activity can improve FMS in children with ASD, even though participating in any physical activity is thought to enhance motor skills in children (20). Guided physical activity can be defined as child-directed physical activity with adult assistance when requested by the child, and it is important to examine if this type of activity can enhance motor skills in children with ASD. This type of activity requires less teacher education and may be more feasible to implement in multiple settings, including children's therapy settings. It may be cost effective and could prove to be more efficient to have trained professionals oversee several kids with the help of aides instead of hiring an adaptive physical education teacher to work one-on-one with kids. Thus, this study aimed to examine if a guided physical activity intervention enhances motor skills in three to eleven-year-old children with ASD.

The following hypothesis were examined: 1. Guided physical activity will improve FMS in autistic children ages 3-10, and 2. Improvement in FMS in autistic children ages 3-10 will be greater than typically developing children.

MATERIALS AND METHODS

Participants. Children with autism were recruited from the Southeast Missouri State (SEMO) University Autism center. Flyers were posted at the front desk, on information bulletins, and sent home with children following their services. Interested parties were instructed to contact the principal investigator to enroll their child. Parental consent and children's assent were collected. For ASD children (verbal and nonverbal), any indication of physical or emotional distress was considered non-assent and they were permitted to exit the study immediately. Typically developing children were recruited through a collaboration with a homeschooling co-op based in Southern Illinois. All recruited children were between the ages of three and eleven. In total, four children with autism (male, n=3; age, 5.6 female, n=1; age, 4; mean age = 4.2) and seven typically developing children (male, n=3; age, 6.3; female, n=4; age, 8.25; mean age, 7.4) completed the study. Aside from participant age, no diagnostic, characteristic, or demographic information was collected. This study received joint approval from the Southern Illinois University Carbondale (SIUC) and Southeast Missouri State University (SEMO) institutional review boards.

Apparatus and Task. Children with ASD participated at the SEMO University Autism Center and typically developing children participated at a university recreational facility. The apparatus included the Test of Gross Motor Development-2 (TGMD-2) (21) to assess and classify children's competence in fundamental motor skills. The TGMD-2 is composed of six locomotor and six object manipulation skills common to children aged three to eleven years ten. Healthy development of the skills tested in the TGMD-2 has been deemed necessary for effective participation in standard physical education. In addition, the TGMD-2 has been successfully used with special populations to identify children who qualify for adapted physical education services (12). Furthermore, it has been demonstrated that the TGMD-2 is a reliable, valid measure of motor development in children ages three to ten (21).

It has been recommended to use visual support (e.g. picture task cards) when administering the TGMD-2 to children with autism (22). However, given the use of modeling (physically demonstrating actions to be imitated by the child) and Language Acquisition through Motor Planning (LAMP; PRC-Satillo) (23) devices (an iPad-like interface that uses pictures to denote words, objects, and actions) already in place at the SEMO University Autism Center, the principal investigator concisely described, demonstrated, and used the participant's individualized LAMP device (when necessary) to prompt the desired motor skill as participants were most familiar with these techniques. The LAMP device functions like a keyboard that allows users to communicate in pictures. For example, to prompt

a horizontal jump, the principal investigator could select a picture of jumping on the keyboard; when selected, the device displays the action and vocalizes the word "jump" simultaneously. LAMP is also customizable, and picture prompts were added to accommodate the TGMD-2 skills when necessary. ASD participants were skilled in the use of their device and could communicate "yes", "no", and "go" to the principal investigator if they did not want to perform a skill or did not want to continue testing. Each skill was presented to ASD participants in this way up to three times, and small rewards (i.e. access to small toy of participant's' choosing) were offered to motivate action. If the participant still made no attempts following the third prompt, the skill was skipped and the skill score was recorded as a zero (23).

Procedures. Baseline TGMD-2 assessments were completed one week prior to the guided physical activity intervention. Children with ASD participated in guided physical activity for sixty minutes, twice per week for ten weeks. Typically developing children participated in group-based guided physical activity for sixty minutes, twice per week for ten weeks. At the time of this study, no standardized physical activity guidelines existed for ASD individuals. However, specifications for the activity environment had been recommended: create distinct boundaries in the activity area, limit equipment to avoid unnecessary distraction, provide one-on-one assistance, and use picture schedules to help establish routine (24). Thus, for ASD participants, the physical activity environment was structured according to the North Carolina Treatment and Education of Autistic and Related Communications-Handicapped Children (TEACHH) guidelines for physical activity (25). Four activity-opportunity stations with distinct boundaries were created: 1) obstacle course, 2) sports equipment, 3) bubbles and balloons, and 4) sensory tag. Upon arrival, participants were presented with an individualized picture schedule. Pictures were used to identify the location and nature of each activity station. At the beginning of each session, the participant was asked to retrieve the first picture (secured with Velcro) from their schedule and carry it to the location of the first station, marked by a folder displaying a matching picture. Within each station, start and finish locations were marked when appropriate (i.e., for the beginning and end of the obstacle course). Equipment was carefully selected to provide an individualized and stimulating environment with limited unnecessary distraction. After locating the first activity station, the principal investigator verbally described, modeled, and used the participant's LAMP device to display activity opportunities and encourage physically active play. After modeling activity opportunities, the principal investigator allowed the child to dictate the nature of play. Within each station, the goal was to encourage as much physical activity as possible without regard to time spent in a particular activity or intensity of activity. Twelve-minutes were allotted to each station, with a three minute station-interchange interval. Typically developing (TD) participated in four group-based physical activity stations involving minimal equipment and no skill teaching (e.g. obstacle course, kickball, tag). Activity protocols were matched to the highest degree possible; however, the activity area, activity schedule, and assistive measures varied between groups as the activity area was not explicitly structured according to the TEACHH guidelines (though boundaries were placed and equipment was limited). Specifically, TD children did not use picture schedules and did not receive one-on-one assistive guidance.

RESULTS

Only children who attended at least ten activity sessions were included in the final analysis (ASD sessions attended, M=13.25, SD=2.06; TD sessions attended, M=17.85; SD=2.86). As expected, ASD and TD children's locomotor, object manipulation, and total skill scores were significantly different on pre-and-post intervention (see Table 1 and 2 for descriptive statistics and Table 3 for pre-post scores in the ASD group).

To assess the hypotheses that guided physical activity will improve motor skills in young children with autism and will improve motor skills in young children with autism more than their typically developing counterparts, the following dependent variables were examined: Gross Motor Quotient (GMQ), locomotor and object manipulation raw subtest scores, and individual skill scores. Motor skill changes in the ASD group were examined using a t-test. A linear regression with pre-intervention FMS scores and group membership entered as predictors was used to examine if motor skill changes elicited through guided physical activity differed based on group membership.

ASD participants' demonstrated increases in locomotor, object control, and GMQ scores, but paired t-test revealed no significant difference pre-to-post intervention (locomotor: t = 0.74, p = 0.05; object manipulation: t = 1.05, p = 0.33; GMQ: t = 0.15, p = 0.88). However, there was a trend for a significant effect of guided physical activity on ASD participants' run (t = 2.6, p = 0.08) and kick (t = 2.36, p = 0.07) performance. Controlling for pre-intervention motor skills, linear regression models revealed that group membership was not significantly associated with the change in children's GMQ or object manipulation skills post-intervention (see Table 4). However, group membership (TD) was significantly associated with the change in children's locomotor skills post intervention (b = 33.78, p < 0.001).

Table 1. Mean and Standard Deviation Values ASD Group

	Pretest	Posttest
ASD (*N* = 4)	*M(SD)*	*M(SD)*
Locomotor Raw Score	5.5 (7.19)	8.25 (1.71)
Object Man. Raw Score	7.5 (8.1)	10.75 (6.9)
GMQ	60.25 (21.27)	62.5 (20.57)

Table 2. Mean and Standard Deviation Values TD Group

	Pretest	Posttest
TYP (*n*=7)	*M(SD)*	*M(SD)*
Locomotor Raw Score	36.00 (6.19)	42.00 (1.82)
Object Man. Raw Score	38.00 (5.65)	37.85 (4.70)
GMQ	96.14 (16.40)	100.42 (10.73)

DISCUSSION

Ten weeks of a guided physical activity intervention did not support statistically significant improvements in ASD children's gross motor skill performance. Further, total motor skill improvements in the ASD group were not greater than in the TD group. However, we observed significant improvement in ASD children's running and kicking performance.

Contrary to our hypothesis, guided physical activity did not significantly improve gross motor quotient (GMQ) scores in ASD participants. GMQ scores reflect normed expectations for motor development in typically developing children, who must achieve at least one additional locomotor and object manipulation skill criterion every six months to maintain positive developmental trajectories (21). In this study, three of four ASD participants exhibited FMS that would qualify as clinically impaired for a 3-year-old, and no participant was younger than four. Most (three of four) ASD participants needed to achieve at least four additional locomotor and object skill criteria, respectively, to improve relative to normative data in a meaningful way. While prior studies support that physical education and physical activity interventions significantly increase ASD participants' GMQ (12, 21, 26) and other important gross motor skills (27), this criterion may not be the best indication of improvements following a guided physical activity intervention where children were not taught nor required to practice FMS but were encouraged to explore intrinsically enjoyable physical activity. Indeed, ASD participants in this intervention chose to engage in running, swinging, throwing, and climbing most often, with little to no time spent directly practicing FMS. It is possible that physical education and recreational activity programming are necessary to elicit large gains in FMS performance in ASD participants. However, future studies should examine (and track) activities that ASD participants engage in during guided play and consider if specific types of activities are more beneficial to children's FMS.

Despite lack of improvement in GMQ scores, twenty sixty minute sessions of guided play were sufficient to develop running and kicking performance (raw scores) in ASD children. This trend aligns with other studies showing that physical education (i.e., motor skill intervention) and physical activity interventions enhance FMS in children with ASD (9-19, 27). Bremer and

Lloyd found that children's jump, strike (i.e., batting a baseball off of a tee), roll, and catch performance improved most after a school-based motor skill intervention for children with autism-like characteristics (i.e., non-confirmed ASD diagnosis) and behavioral issues (12). A similar school-based intervention reported that children with intellectual disabilities (including ASD) significantly improved in locomotor skills, object control skills, and balance, with children's motor skill gains equating to seven months of development across an eight-week intervention (21). Our findings, and those from prior studies, may have important development implications. For example, improved running may acclimate children to brief, single-leg support and help them become more comfortable hopping on one foot or galloping. Additionally, proficient running may support increased physical activity, enhance health related quality of life (i.e. aerobic fitness and weight control), and allow children to begin participating in one-on-one games of tag or simple races. If it is the case that improving one or two motor skills enables children to participate in or practice a wider range of activities, the snowballing effect of improved running and kicking skills is likely to assume immense benefit for ASD children.

Table 3. Pre- and post-intervention skill scores for the ASD group

	A01		**A02**		**A03**		**A04**	
Skill	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*
Run	3	6	0	6	2	6	6	6
Gallop	0	0	0	0	0	4	4	0
Hop	1	0	0	2	0	0	0	0
Leap	0	0	0	4	0	0	3	2
Slide	0	0	0	0	0	0	3	1
Jump	0	0	0	0	0	0	0	0
Bat	2	2	0	3	2	2	5	2
Dribble	0	0	0	0	0	0	0	2
Catch	0	0	0	0	0	0	3	2
Kick	3	6	0	5	4	4	4	6
Throw	0	0	0	0	0	0	3	7
Roll	0	0	0	0	0	0	4	2

Although our findings did not align with our original hypotheses, it is critical to acknowledge that a brief (ten weeks) guided physical activity intervention was sufficient to improve running and

kicking skills in ASD participants for two reasons. First, implementing a guided physical activity intervention requires little equipment and little professional training and may be feasible to implement in multiple settings (e.g., school, therapy, home). For example, this intervention was implemented for ASD participants within their therapy setting and with the help of behavioral therapy implementers who did not have training in physical education or recreational programming. Secondly, ASD participants engaged in an average of 1.06 hours of guided physical activity per week after accounting for attendance rate (mean attendance = 13.25 sessions) and intervention time (48/60 minutes). Thus, our positive findings shed light on the potential efficacy of brief, minimally instructive approaches to enhancing motor skills in children with ASD and highlight the value of self-directed, physically active play with a guide for this population.

Table 4. Linear regression models predicting the change in children's motor skills post-intervention from pre-intervention motor skills (control variable) and group membership

Predictor	*F*	*df*	*b*	*t*	R^2
Model 1	**403**	**2,8**			**0.99*** **
Locomotor skills			-0.00	-0.013	
Group			33.79***	10.635	
Model 2	**110.8**	**2,8**			**0.97*** **
Object Manipulation Skills			0.71*	4.635	
Group			5.19	1.018	
Model 3	**39.13**	**2,8**			**0.91*** **
GMQ			0.69*	4.699	
Group			12.95	1.764	

Note: * =< .05; *** =< .001

Strengths & Limitations. Our findings are limited by the small sample size and use of unmatched controls, similar to other literature in this area (12). Additionally, this study did not measure the children's actual time in physical activity or track the types of physical activity participants engaged in during sessions. Future studies should replicate this guided physical activity intervention with pedometers, accelerometry, or video analysis to better understand the characteristics of physically active play that improve FMS and examine the amount of activity necessary to produce benefits for children with ASD. Further, assessing other child outcomes (e.g., social and behavioral) and parents' perceptions may provide knowledge about the benefits of guided physical activity beyond FMS.

Strengths of this study include use of the TEACCH guidelines to structure the physical activity environment and the individualization of FMS assessments for ASD participants. The

TEACCH guidelines outline specific criteria to support ASD children's engagement in physical education. We used these guidelines to design an inviting environment for physically active play and allowed participants to direct the type of play. Additionally, it is recommended to use visual support when delivering the TGMD-2 to ASD children (21). In the present study, ASD participant's individualized LAMP device served as a visual, auditory stimulus prompting the desired motor skill performance. Use of children's personalized LAMP devices supports the validity of our results because it ensured test comprehension during pre-and-post intervention FMS assessments for ASD participants.

CONCLUSION

FMS interventions effectively improve FMS in children with ASD, but they require resources (e.g., special education professionals and teacher education) that may not be accessible to all. This exploratory study provides some preliminary evidence that guided physical activity supports the development of FMS in children with ASD. The findings of this study should be explored in larger studies with matched controls. However, it is vital to acknowledge that guiding ASD children's physical activity in a supportive environment may meaningfully contribute to their FMS development which expands knowledge about FMS interventions for this population.

APPLICABLE REMARKS

- Guided physical activity should be explored as a potential means of enhancing fundamental motor skill development in children with autism.
- These interventions may be feasible to implement in multiple settings, including school and therapy settings.

ACKNOWLEDGMENTS

We would like to thank the families and children who participated in this study. Our research would not be possible without them. We would also like to acknowledge and thank the Southeast Missouri State University Autism Center for welcoming this research project and allowing us to use their facilities.

AUTHORS' CONTRIBUTIONS

Study concept and methodology: S.A.P. and V.N.P.A. Data collection: S.A.P. and V.N.P.A. Intervention: S.A.P. Statistical analysis: S.A.P. and V.N.P.A. Manuscript writing and editing: S.A.P., V.N.P.A., T.A., A.R., G.E., and F.S.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. Data & Statistics on Autism Spectrum Disorder: Cdc.gov; 2023 [Available from: https://www.cdc.gov/ncbddd/autism/data.html].
2. Ramshini M, Karimi H, Hassan Zadeh S, Afrooz G, Hashemi Razini H, Shahrokhian N. The Effect of Family-Centered Nature Therapy on the Sensory Processing of Children with Autism Spectrum. International journal of Sport Studies for Health. 2018;1(4):e85506. [doi:10.5812/intjssh.85506]
3. Erfanian F, Hashemi Razini H, Ramshini M. The Relationship Between Executive Functions and Sensory Processing with Emotional Recognition in Autism Spectrum Disorder. International journal of Sport Studies for Health. 2018;1(2):e74071. [doi:10.5812/intjssh.74071]
4. Gandotra A, Kotyuk E, Szekely A, Kasos K, Csirmaz L, Cserjesi R. Fundamental movement skills in children with autism spectrum disorder: A systematic review. Research in Autism Spectrum Disorders. 2020;78:101632. [doi:10.1016/j.rasd.2020.101632]
5. MacDonald M, Lord C, Ulrich DA. Motor skills and calibrated autism severity in young children with autism spectrum disorder. Adapt Phys Activ Q. 2014;31(2):95-105. [doi:10.1123/apaq.2013-0068] [PMid:24762385]
6. Clark JE, Metcalfe JS. The mountain of motor development: A metaphor. Motor development: Research and reviews. 2002;2(163-190):183-202.
7. Bremer E, Cairney J. Fundamental Movement Skills and Health-Related Outcomes: A Narrative Review of Longitudinal and Intervention Studies Targeting Typically Developing Children. American Journal of Lifestyle Medicine. 2018;12(2):148-59. [doi:10.1177/1559827616640196] [PMid:30202387]

8. Lubans DR, Morgan PJ, Cliff DP, Barnett LM, Okely AD. Fundamental movement skills in children and adolescents: review of associated health benefits. Sports Med. 2010;40(12):1019-35. [doi:10.2165/11536850-000000000-00000] [PMid:21058749]
9. Stodden DF, Goodway JD, Langendorfer SJ, Roberton MA, Rudisill ME, Garcia C, et al. A Developmental Perspective on the Role of Motor Skill Competence in Physical Activity: An Emergent Relationship. Quest. 2008;60(2):290-306. [doi:10.1080/00336297.2008.10483582]
10. Healy S, Nacario A, Braithwaite RE, Hopper C. The effect of physical activity interventions on youth with autism spectrum disorder: A meta-analysis. Autism Res. 2018;11(6):818-33. [doi:10.1002/aur.1955] [PMid:29693781]
11. Ruggeri A, Dancel A, Johnson R, Sargent B. The effect of motor and physical activity intervention on motor outcomes of children with autism spectrum disorder: A systematic review. Autism. 2020;24(3):544-68. [doi:10.1177/1362361319885215] [PMid:31782658]
12. Bremer E, Lloyd M. School-Based Fundamental-Motor-Skill Intervention for Children With Autism-Like Characteristics: An Exploratory Study. Adapt Phys Activ Q. 2016;33(1):66-88. [doi:10.1123/APAQ.2015-0009] [PMid:26785501]
13. Cei A, Franceschi P, Rosci M, Sepio D, Ruscello B. Motor and psychosocial development in children with autism spectrum disorder through soccer. International Journal of Sport Psychology. 2017;48(5):485-507.
14. Hayward LM, Fragala-Pinkham M, Johnson K, Torres AR, editors. A Community-Based, Adaptive Soccer Program for Children with Autism: Design, Implementation, and Evaluation2016.
15. Arzoglou D, Tsimaras V, Kotsikas G, Fotiadou E, Sidiropoulou M, Proios M, et al. The effect of [alpha] tradinional dance training program on neuromuscular coordination of individuals with autism. Journal of Physical Education and Sport. 2013;13(4):563.
16. Kokaridas D, Demerouti I, Margariti P, Krommidas C. The Effect of an Indoor Climbing Program on Improving Handgrip Strength and Traverse Speed of Children With and Without Autism Spectrum Disorder. Palaestra 2018;18(3):39-44.
17. Sarabzadeh M, Azari BB, Helalizadeh M. The effect of six weeks of Tai Chi Chuan training on the motor skills of children with Autism Spectrum Disorder. J Bodyw Mov Ther. 2019;23(2):284-90. [doi:10.1016/j.jbmt.2019.01.007] [PMid:31103109]
18. Pan CY, Chu CH, Tsai CL, Sung MC, Huang CY, Ma WY. The impacts of physical activity intervention on physical and cognitive outcomes in children with autism spectrum disorder. Autism. 2017;21(2):190-202. [doi:10.1177/1362361316633562] [PMid:27056845]
19. Guest L, Balogh R, Dogra S, Lloyd M. Examining the impact of a multi-sport camp for girls ages 8–11 with autism spectrum disorder. Therapeutic Recreation Journal. 2017;51(2):109. [doi:10.18666/TRJ-2017-V51-I2-7383]
20. Ulrich DA, Sanford CB. Test of Gross Motor Development : examiner's manual. 2nd ed ed. Austin, Tex. (8700 Shoal Creek Blvd., Austin 78757): Pro-Ed; 2000.
21. Ketcheson L, Hauck J, Ulrich D. The effects of an early motor skill intervention on motor skills, levels of physical activity, and socialization in young children with autism spectrum disorder: A pilot study. Autism. 2017;21(4):481-92. [doi:10.1177/1362361316650611] [PMid:27354429]
22. Breslin CM, Rudisill ME. The effect of visual supports on performance of the TGMD-2 for children with autism spectrum disorder. Adapt Phys Activ Q. 2011;28(4):342-53. [doi:10.1123/apaq.28.4.342] [PMid:21914906]
23. LAMP words for life: PRC-Studio; 2021 [Available from: https://lampwflapp.com/].
24. Srinivasan SM, Pescatello LS, Bhat AN. Current perspectives on physical activity and exercise recommendations for children and adolescents with autism spectrum disorders. Phys Ther. 2014;94(6):875-89. [doi:10.2522/ptj.20130157] [PMid:24525861]
25. Schopler E, Mesibov GB, editors. Behavioral Issues in Autism: Springer US; 1994. [doi:10.1007/978-1-4757-9400-7] [PMid:7855710]
26. Favazza PC, Siperstein GN, Zeisel SA, Odom SL, Sideris JH, Moskowitz AL. Young Athletes program: impact on motor development. Adapt Phys Activ Q. 2013;30(3):235-53. [doi:10.1123/apaq.30.3.235] [PMid:23860506]

27. Henderson H, Fuller A, Noren S, Stout VM, Williams D. The effects of a physical education program on the motor skill performance of children with autism spectrum disorder. Palaestra. 2016;30(3):41-50.